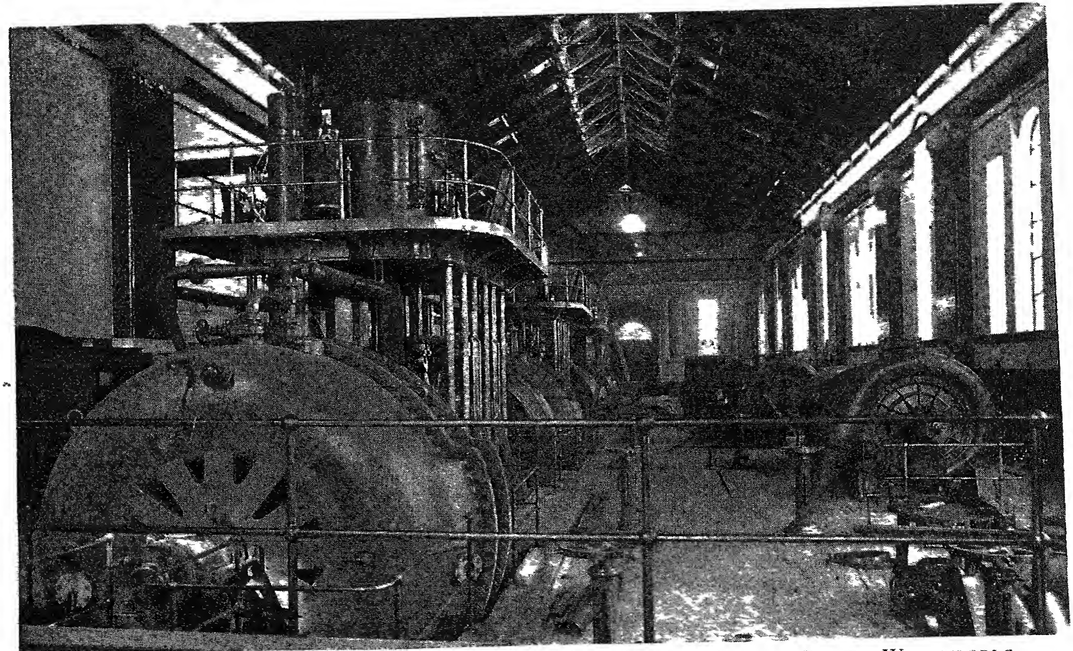
JOURNEYS IN
INDUSTRIAL ENGLAND



VERTICAL STEAM-ENGINES AND CENTRIFUGAL PUMPS AT THE WALTON-UPON-THAMES WATERWORKS

JOURNEYS IN INDUSTRIAL ENGLAND

BY

WILLIAM J CLAXTON

AUTHOR OF
'RAMBLES AMONG OUR INDUSTRIES' 'OUR COUNTRY'S INDUSTRIAL HISTORY'
'RAMBLES IN RURAL ENGLAND'
ETC. ETC

LONDON
GEORGE G. HARRAP & COMPANY
2 & 3 PORTSMOUTH STREET KINGSWAY W.C.
1915

Printed in Great Britain
Turnbull & Spears, Edinburgh

PREFACE

A WRITER, in describing the great market-places of the world, says: "Three nations stand out pre-eminently in the world of trade: the United Kingdom, the German Empire and the United States of America. Between them they share an incredibly large proportion of the world's commerce, own most of the world's ships, smelt most of the world's iron, build most of the world's railways, furnish nearly all the world's machinery, produce the greater part of the world's machine-made articles, and possess among their citizens most of the world's millionaires."

This being the case it seems fitting that English children should have some insight into the great national industries of their country. I have tried to give them the material for this in a number of imaginary tours among our chief centres of industry.

This book makes no pretence of going minutely into the processes employed in various manufactures—this I have done in another series of books—but rather is it my aim to bring before my readers a little of the romance and a little of the reality of the great industries by which the busy industrial life of this country is sustained. The coincidence of the great coal-fields and the factory districts is logically explained, together with the "speeding-up"

of commerce by the construction of canals and other means of transport.

I have tried to show as unostentatiously as possible something of the *nobility* of industry, and to impress upon the children that all that we call progress—civilization, well-being and prosperity—depends upon industry, diligently applied, from the culture of a barley-stalk to the construction of a steamship—from the stitching of a collar to the carving of a peerless statue.

Finally, I wish to thank Messrs Lever Brothers for information given in Chapter VIII., and the manufacturers and others who have kindly supplied me with information describing their works, and who have lent the photographs which embellish my book.

W. J. C.

CONTENTS

JOURNEYS IN INDUSTRIAL ENGLAND

CHAPTER I

THE MILL ON THE MARSH[1]

OUR first journey takes us across a large tract of marshland, which is intersected by a river with its numerous little tributaries. There are few houses on the marsh, but in the centre there may be seen a pile of buildings surmounted by the tall chimney-stalks which, as we shall see, are generally associated with industrial factories. As we approach the main building we hear the whirr and buzz of machinery, and jets of steam issue from many pipes in various parts of the walls.

In this lonely factory there is manufactured one of the most useful, and one of the most common, commodities of mankind. This is paper.

It is hard to realize how our forefathers of long ago transacted their business and arranged their affairs without the use of paper, for though the manufacture of paper cannot be described as a modern industry, yet it was not until the fifteenth century that John Tate set up the first English paper-mill in Hertfordshire. This was succeeded by a much larger mill erected by a German at Dartford, Kent, in 1568, and this mill laid the foundation of our important paper-making industry.

[1] The illustrations in this chapter are from photographs supplied by Messrs Edward Lloyd, Ltd

An extract from the German mill-owner's licence ran: "for the gathering of all manner of linnen raggs, scrolls, or scraps of p'chment, pease of lymes, and clippings of cards, and oulder fishinge nettes, for the making of all or anie sort or sorts of white wrighting paper, and forbidding all other p'sons for the making of paper, for the space of ten yeres next."

The old proverb, "Familiarity breeds contempt," may well be applied to the use of paper. Paper is such a part of our everyday life that, having it always before us in some form or other, we think little about it. The best way to realize the use of a thing, in some cases, is to imagine what the result would be if we were without it. One great writer says of paper: "Without water, which is the paramount gift of Nature, every living thing would perish; without paper—which is an artificial creation, the work of man's hands—civilization would perish intellectually. Without paper there could be no diffusion of knowledge. The art of printing would have been valueless had there been no paper. We might convert the hide of every available animal into parchment on which to score our records without furnishing a substitute for paper. . . . All the learning of the world is committed to paper. The secrets of health, of commerce, of invention and industry, all the music of the dead immortals, all the philosophy and eloquence and varied poetic glories of ancient and modern seer and singer—all is bequeathed to us on paper."

But let us return to the mill on the lonely marsh. "Why should the paper-mill stand out here by itself?" you ask. The railway station is nearly two miles away, and there is only one road running across the marsh from the station to the mill.

There are two main reasons why the mill-owner chose this site. The first is that there must be a plentiful supply of clean water. Water is as necessary to the making of paper as coal is to the smelting of metals, or ink to the printer. The second reason is that the water running over this marsh is of just the right quality for reducing the raw materials to pulp. Some water is too "hard," and other water is too "soft." All paper-mills do not stand in such isolated positions as this one, but they are never found in the centre of large towns, as are the mills and factories of many industries. Our largest paper-mills are in Kent, Hertfordshire, and Lancashire, and in the villages near some great towns, for when the older mills were erected the chief raw materials were linen rags, which were supplied by the people of the towns. In those days the old rag-a-bone men might have been seen carrying their sacks of rags to the paper-factory, and as there was a great demand for rags, the manufacturers had to pay a good price for them. Indeed, this demand really crippled the rag-a-bone man's trade, for he could not supply the rags fast enough, and manufacturers soon found very efficient substitutes for rag. The chief of these are esparto grass, which grows in Africa and Spain, hemp ropes, flax, cotton, straw, cocoanut fibre, hay, grass, seaweed, old paper repulped, mechanical and chemical wood pulp, and the dried stalk of the sugar cane. For the very best paper, such as that made up into writing notepaper, the manufacturer uses linen rags, but for the very cheap paper, used for newspapers and many books, wood pulp is required. Much of the paper used in your school-books is made from esparto grass, while packing paper and strong brown paper are made from old rope, hemp, and straw.

At our paper-mill on the marsh the esparto grass arrives in big round bales, about four feet in circumference, which are done up with stout ropes. Bales of wood pulp are also seen, for, of late years, many paper manufacturers have introduced wood pulp into their mills. Some of the raw material, such as rags and grass, are pulped in the English mills, but wood, which grows abroad, is sometimes pulped before being sent to England. When ready to be shipped the pulp is in sheets, about three feet by two feet, and it somewhat resembles packing cardboard.

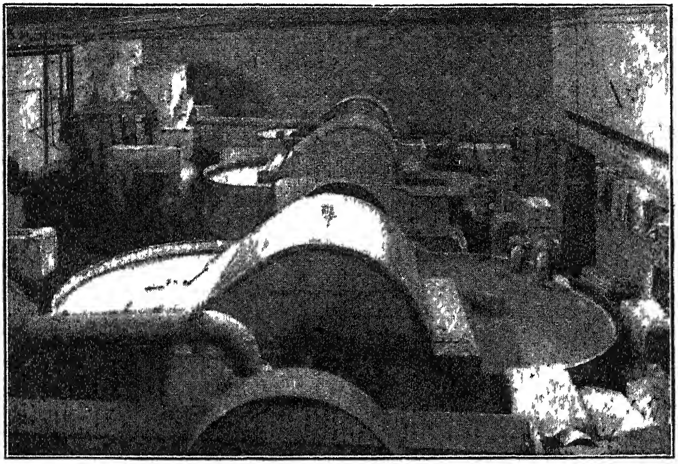
We see that in this mill rags are being treated to-day. We enter the *sorting-room* and find a number of women sorting them into various qualities, for linen rags make paper of higher quality than cotton. The rags are next cut into pieces about four inches square. The cutting is not done by scissors, but by very sharp knives which are set in benches face upward, and the women draw the rags across the blades.

The next room we enter is the *dusting-room*. Here we see a rag-dusting machine, or willow, which is fitted with spikes, and shaped in the form of a cylinder. When the rags pass into the machine they are whirled and tossed about so that much of the dust is shaken out. After the dusting process is complete the rags are boiled in a lye, which is water impregnated with soda, and this frees them of grease and dirt.

The next machine we visit is the *breaker*. This is in the form of a heavy roller armed with blunt knives, which revolves on an iron plate set in a trough containing water. The rags are drawn between the roller and the plate, and their fibres are pulled out. The breaker needs much water, and while the dirty water is extracted by

a machine called a *washer*, a stream of fresh water runs in. After being buffeted and tossed and torn for an hour or two in the breaker, the rags emerge in the form of pulp or paste.

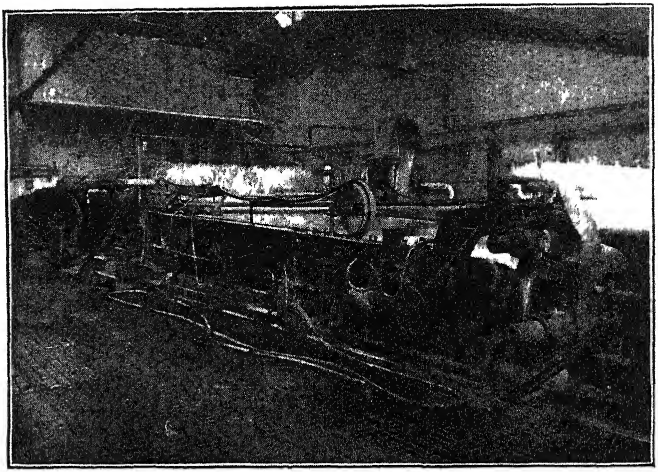
From the trough the rags enter the *bleaching-vat*, where they remain under the action of a solution of chloride



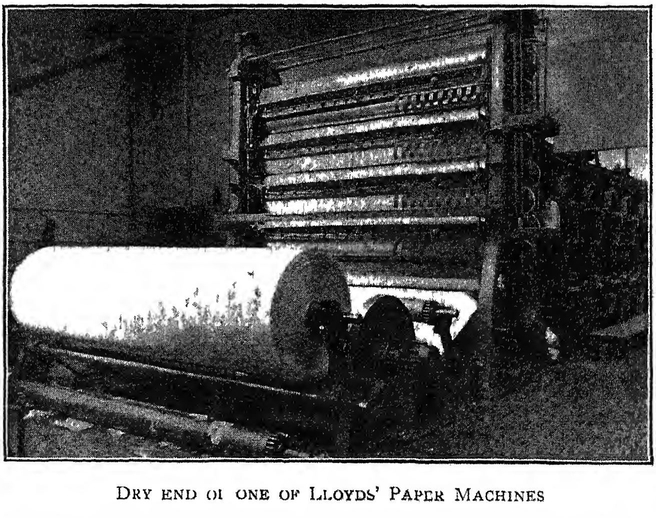
BEATING MACHINE

of lime for several hours. The bleached pulp is then drained, and any remaining liquor is removed by pressing the pulp in a press.

We have seen only the preparatory stages of the manufacture of paper. The coarse, dried pulp is now placed in a *beater*, which grinds it by numerous knives set on a heavy roll which runs over a grooved plate. The beater is very much like the breaker, but the knives are sharper and the grooves smaller.



Wet end of one of Lloyds' Paper Machines



Dry end of one of Lloyds' Paper Machines

After the pulp has been churned and strained, it resembles thick cream or curds, and at this stage dye is added. When it is thoroughly strained from lumps, knots, etc., in the refiner, it runs through pipes to the *paper-making machine.* This is a most intricate machine nearly two hundred feet long, and containing a moving belt

Paper for "Lloyds' News" being carried up Fleet Street

Unloading Paper at Lloyds' Wharf

of brass wire cloth with sixty or seventy meshes in a square inch. The pulp runs on to the belt, and as it is carried along by the moving belt it is rocked from side to side, so that much of the water is shaken out and drained through the wire, and the fibres are knit together. As the pulp reaches the dry end of the wire belt it becomes thicker, and any remaining moisture is extracted by powerful suction pumps. At this stage, too, the *watermark* is pressed

into the pulp by a revolving cylinder which has on its surface the design of the watermark. (You may see the watermark of a sheet of foolscap or notepaper by holding it up to the light)

From the paper-making room we pass into the *drying* and *calendering room* where the paper is dried and a glossy surface is given to it. Finally, we enter the *cutting* and *packing room* where the finished paper is cut into sheets, and women and boys sort and pack it into reams ready for sale.

CHAPTER II

THE NEWSPAPER OF TO-DAY

LET us to-day make a tour round the "office" of one of our largest newspapers.

It would be best, perhaps, to start in the editorial department, for it is there that the news from all parts of the world first comes.

RECEIVING NEWS BY TAPE-MACHINE AND RETRANSMITTING BY TELEPHONE IN LLOYDS' PRINTING OFFICE

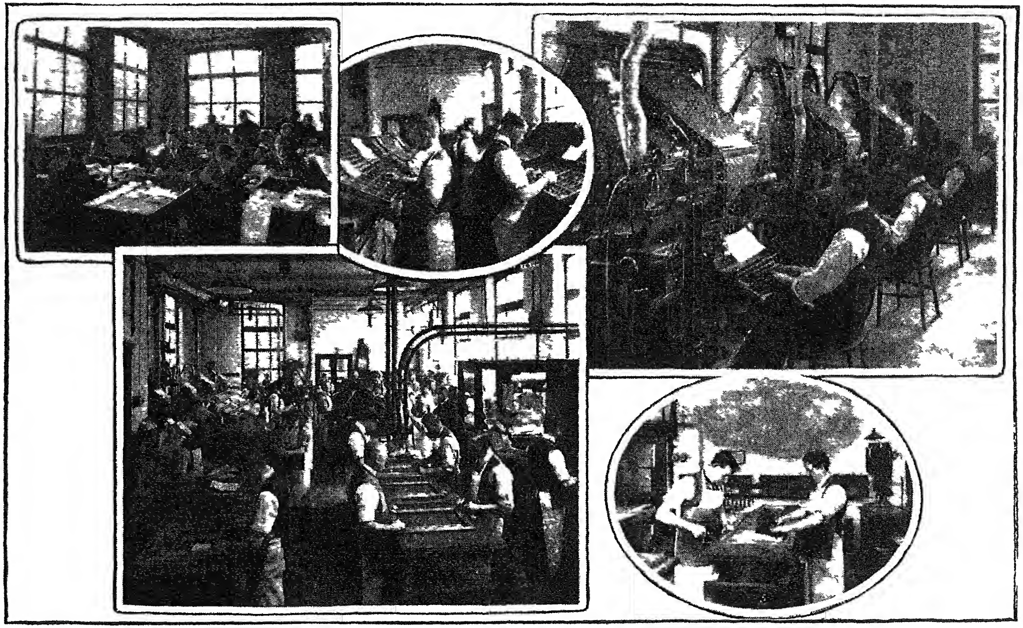
A large newspaper has correspondents in all the chief towns in the world, but much of its news is received from News Agencies, such as Reuter's, The Central News, and the Press Association. All day and night news pours into the editorial office through the telephone, the tape-machine and by telegraph. It is, as a rule, in very brief form, and it is part of the work of the sub-editor to give these brief messages the necessary literary shape.

A great portion of the news, however, has to be considerably cut down, for a large newspaper receives enough copy in one day to fill many issues.

When the copy is ready it is conveyed to the Composing Room by means of a pneumatic tube. A bell warns the compositors to be on the alert, and the copy is immediately divided between several operators, who proceed to set it up.

Competition nowadays is so great that additional time required in the production of a particular newspaper is a handicap, and therefore the successful proprietor is forced to install all the latest appliances for saving time. One of the most remarkable of these is the Linotype. It is driven by a low-power electric motor, and is worked by a single operator by means of a keyboard similar to that of the typewriter. As the man requires a letter he touches a particular stop which releases a matrix from the magazine and causes it to fall into a receptacle in front of him. This matrix is made of brass and is about an inch deep. On the bottom the form of the letter is cut out and it is also stamped on the edge, which is in view, so that the operator can easily detect any typographical error. The line of matrices is then transferred mechanically into the casting section of the machine, where the miniature foundry casts the lines and delivers the " slugs " at the rate of about six a minute, cut and trimmed to length, breadth and height. The working of the foundry in no way interferes with the keyboard, for while a casting is being taken from one line of matrices another is being assembled by the operator.

The matrices, after casting, are returned to their places in the magazine. The slugs are transferred from the linotype machine to an imposing stone, where they are



COMPOSING DEPARTMENT OF LLOYDS'

Reading Room — Setting type by hand — Linotype machines.

Composing Room. — Locking up a forme

made up into columns. The paragraph headings are, as a rule, set up by hand, and when these have been inserted in their proper places, a sufficient number of columns to make one page of the paper are locked up in an iron frame or "chase," and this is then known as "a forme." An impression is now taken and passed to the Reading Room, where it is carefully read and corrected. The proof is then returned to the compositor, who makes the necessary corrections, after which the forme is ready for the stereographer.

The Foundry, as a rule, is not a place where one would care to stay long, for the heat is very trying. But it is here that a very important and interesting work is done.

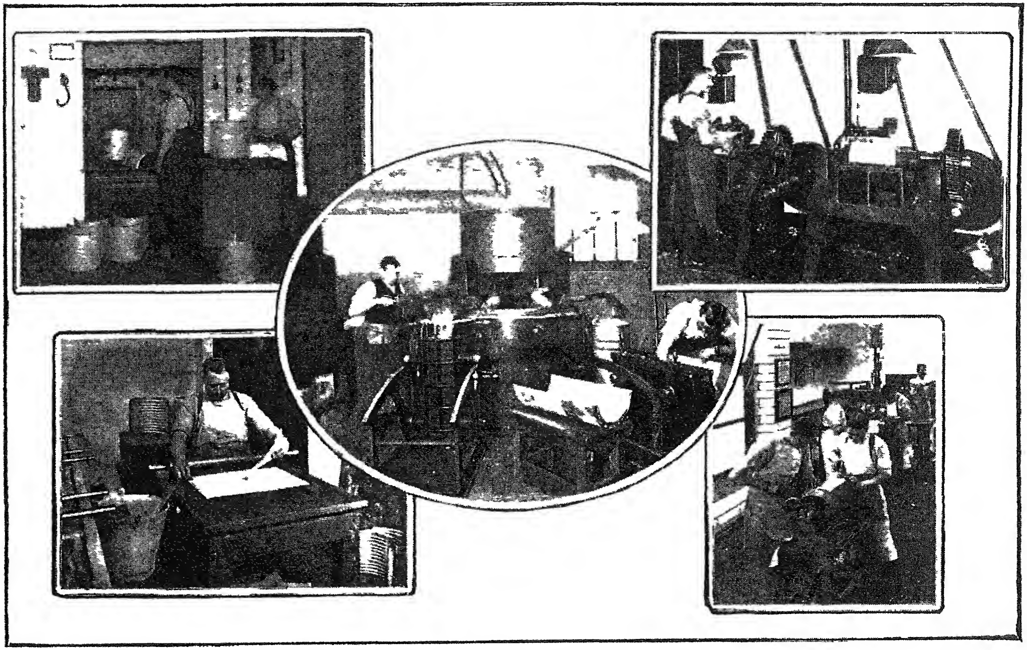
First, the surface of the type is well brushed to remove any superfluous metal; then a papier mâché mould is taken of each forme. Next, the mould is dried by a rapid mechanical process, and although only a little thicker than brown paper it is very tough and strong, and several castings may be taken from it.

As the printing is done on a rotary machine it is necessary that the plate should be cylindrical, and therefore the casting box in which the mould is placed is semicircular in shape. Metal is poured in, and the result is a stereoplate. This is bored or planed to an even thickness of seven-sixteenths of an inch, and cooled.

It is now ready to be printed from, and we will accompany it, say, to the machine room of "Lloyd's News."

Here we find an array of seven Double Octuple Perfecting machines, which, together, are capable in one hour of printing, folding and delivering 55,000 copies of a thirty-two page paper.

Each machine is driven by two seventy-five horsepower electric motors, which can be worked separately



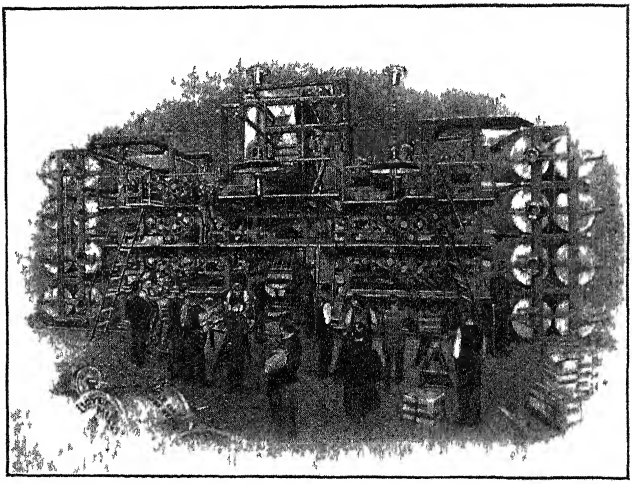
STEREOTYPING DEPARTMENT OF LLOYDS'

Sending plates to Machine Room
Making papier mâché.

Casting plates.

Boring plates.
Dressing plates.

or together, and it contains sixteen cylinders, upon which the stereoplates, which print both sides of the paper, are secured. Every cylinder prints eight pages with one revolution. Eight plates to print pages one and thirty-two in quadruple would be arranged, for example, on one cylinder.



ONE OF LLOYDS' DOUBLE OCTUPLE PRINTING MACHINES

Eighteen men are required to work each machine; half a ton of ink must be put in the ink reservoirs; and when running at full speed nearly three hundred miles of paper are consumed in an hour.

The paper is fed into the machine from two revolving turrets, one at each end. Each carries eight enormous rolls, four of which are used at one time.

When the eight inside rolls are exhausted the machine

is stopped and the turrets reversed; the broken ends of paper are pasted to the free ends of the new rolls, and the press once more is set in motion.

Eight more reels are raised, by hydraulic lifts, into the empty places on the outside of the two turrets, ready for another change.

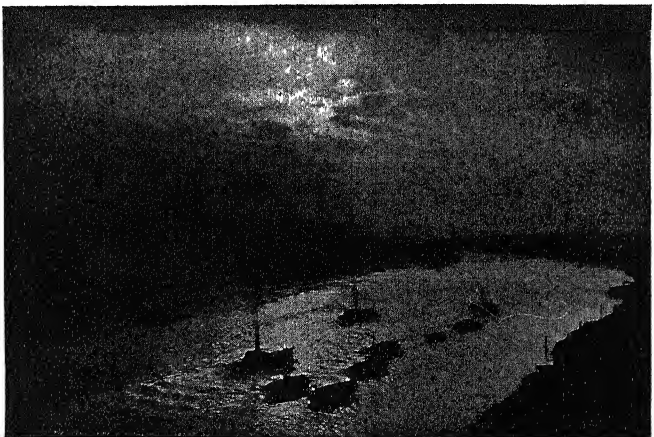
As the paper is printed it is conveyed into the centre of the machine, where it is cut, folded and delivered, counted in quires of twenty-six complete newspapers. These are packed in bundles of 130 copies each, and are then placed upon a revolving elevator, which conveys them to the Publishing Department to be distributed throughout the country by cycles, carts, motors, trains, and other means.

The rapidity at which the modern newspaper is produced is amazing. A good illustration of this is to be seen at the close of an important football match when, on leaving the ground, you may purchase a newspaper containing news of the result which you have witnessed but a few moments previously.

CHAPTER III

A TRIP DOWN THE TYNE

TO-DAY we are going for a short trip down the Tyne, commencing our voyage at Newcastle, and ending it at Tynemouth. It is certain that we shall not pass through



Photo, J. Valentine

TYNESIDE

beautiful scenery, such as that found in the upper reaches of the Thames, or along the delightful Wye, but we hope to get some idea of a few of England's great industrial cities as they appear from the water.

It is about ten miles from Newcastle to the sea, but

during this short trip we shall pass by some of the busiest wharves and docks in the world. There is almost one continuous chain of factories, coal-yards, timber-yards, glass-warehouses, and shipbuilding yards. All manner of craft ply up and down the river, the incoming ships and barges mostly laden with timber from the Baltic-lands, corn from Russia, dairy produce from Holland, and pitch and tar from Norway; the outgoing ones with cargoes of coal, glass, lead, and iron goods. The ugly-looking, dirty coal-vessels, drawn by fussy little tugs, greatly outnumber other vessels, and many of them are bound for London.

We wonder why such a comparatively narrow river should be able to float all these craft, but we learn that much labour has been expended on the bed of the Tyne, so that at this point there is a depth of twenty feet at low water. Dredgers are constantly at work, and engineering operations for the improvement of the river's navigation have been carried out at enormous expense.

Opposite Newcastle is Gateshead, and the two towns are joined by a number of fine bridges, the chief of which is the High Level Bridge, which was constructed by Robert Stephenson. This bridge is more than a quarter of a mile long, and there are really two bridges, one above the other. The upper one is used for trains, and it is over 100 feet above high-water mark; the lower is used by pedestrians and vehicles.

We are inclined to think of Newcastle only as concerned with coal, but there are several other important industries carried on in the town. There are hemp and cordage works, important glass and chemical works, shipbuilding yards, factories for the construction of locomotives and marine engines, large timber warehouses,

and smaller factories where anchors, ships' cables and sails are made. Gateshead has similar industries, as well as many brass, copper and iron foundries.

Soon after leaving the busy wharves of Newcastle we come to Jarrow, which stands about six miles farther down the Tyne. Of late years this town has made rapid progress, owing to the development of important ship-building yards and smelting industries. Wallsend is quite near, and from this town an enormous amount of the well-known Wallsend coal is exported.

Newcastle, Wallsend and Jarrow remind us of ancient English history. The former town takes its name from a Norman stronghold—the "New Castle," which was erected soon after the Conquest. Wallsend was so named because it was situated at the eastern end of the Roman wall. Jarrow will always be associated with the life of the venerable Bede.

We are glad to escape from the noise of the numerous factory sirens and hooters, but the river is very congested, and our progress is slow. As we approach the sea we see huge towns, with a forest of chimney-stalks for miles around. Near its mouth the Tyne widens into a bay, and on its north bank stand the towns of North Shields and Tynemouth, while the sister town of South Shields stands on the opposite bank. Tynemouth and North Shields are really one large town, and they contain extensive coal-wharves.

We find even more coasting-colliers taking in their cargo at these ports than higher up the river, for many collieries in the Northumberland and Durham coal-field send their coal direct to the mouth of the river rather than to Newcastle or Jarrow, so as to avoid the slow journey down to the sea.

CHAPTER IV

AN UNDERGROUND TRIP

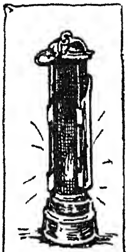
To-day we will enter the miner's cage, which is suspended at the mouth of a shaft or tube that runs many fathoms deep down into the mysterious coal mine.

Coal is used in almost every English home, and it is well that we should see the brawny-armed miner engaged in his arduous task of winning the coal from the black seams in which he works.

Just imagine for a moment what would happen to our industrial life if the country's coal supply was suddenly exhausted. The general strike of coal-miners a few years ago gives us some idea of the great disasters which occur to commerce and industry when the output of coal ceases. For very many years Great Britain produced more coal than any other country in the world, and this was one of the main reasons of her great wealth, as she had the enormous advantage of a successful start over all her trade rivals. The importance of coal in industry is shown by the numerous factories and workshops to be found on the great coal-fields.

Though coal has been lying in strata deep down in the ground for many thousands of years, the mining industry is a comparatively modern one. In the time of the Norman and Plantagenet kings the chief fuel was wood, and charcoal, which was obtained from wood. Three centuries ago the annual output of coal was about two

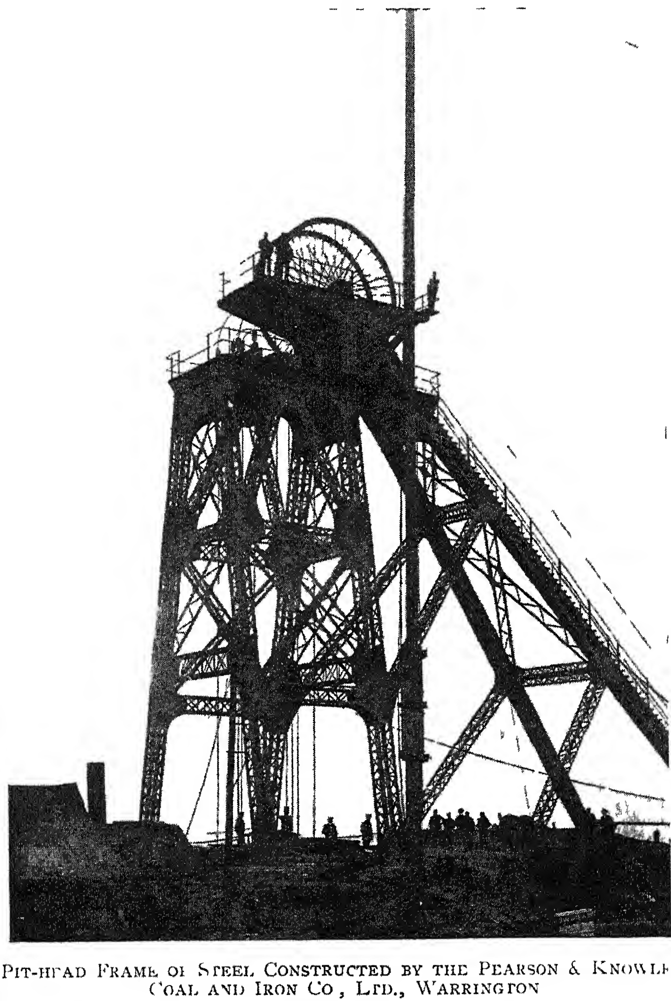
million tons; in 1910 we mined over 264 million tons, valued at the pit's mouth at about £108,000,000. There are coal strata in almost every part of England, but in many places they are so very deep down in the ground that at present it does not pay to work them. Borings have been made in parts of Kent, and coal has been found and mined there, but at present the Kentish coal industry is in its infancy. The principal English coal-fields lie to the west of a line drawn from Flamborough Head to Portland Bill.



SAFETY LAMP

A great change takes place in the country-side when a coal-field is opened up. The dales and dells and hills and valleys, which were pleasant to look upon, give place to busy towns over which a pall of smoke constantly hangs. The trees are felled because their trunks are wanted as props to support the roofs of the mine; the air for miles around is impregnated with coal-dust; the villages are laid out in rows of slate-roofed, brick-built miners' cottages; the stunted shrubs and withering grass are grimy with coal; and around the shaft-head and engine-house of the mine, enormous mounds of coal and refuse are stacked, and the rattle of dirty coal-trucks drawn by puffing engines is heard both day and night.

But let us descend the mine and see what underground life is like. As we approach the shaft-head we notice a pair of monstrous wheels raised high in the air, and running around them are two mighty cables. Below the wheels we see the engine-house; at least we think it is the engine-house, because we hear the persistent thud of a powerful engine.



PIT-HEAD FRAME OF STEEL CONSTRUCTED BY THE PEARSON & KNOWLES COAL AND IRON CO., LTD., WARRINGTON

We take our miner's lamp and step into the "cage," which is a kind of rough-looking truck, or skip, and the engineman starts the engine which causes the cable to commence running so that we descend the shaft. We grip the iron rail as the oscillating cage is rapidly lowered, and the murky darkness of the shaft frightens us. It seems that we are going miles down into the ground. The descent is so rapid that we feel a pain in our ears. Those of us who have been used to descending in the lift of a "Tube" railway have had something of this experience before, but in place of the brightly-illuminated lift, we are in a dismal, grimy box, and our journey is many times longer.

At last the cage stops, and we step out into the cool, dark, silent world. Distant rumblings, like the roll of thunder on a summer evening, may be heard at intervals, and soon a truck, drawn by a pit pony, arrives at the bottom of the shaft. It is at once run into the cage, a signal is given, and away the coal goes to the light of day, after having been buried for long ages.

Branching off in all directions are wide tunnels, and as we pass along one of these tunnels we notice that it, too, is branched. The main roads of the mine are wide and roomy, and a double line of rails run along from the workings to the shaft. The roof and sides are supported by rough beams. We are surprised that we do not have to crawl and stoop when walking down the passages, but our guide tells us that our journey will not be quite so comfortable when we penetrate farther into the workings. Neither is the air foul and stuffy as we imagined it would be, for a powerful ventilating fan draws the pure mountain breezes into the mine, while

that it will be known who mined the coal when the miners come up for payment of the "piece-wage."

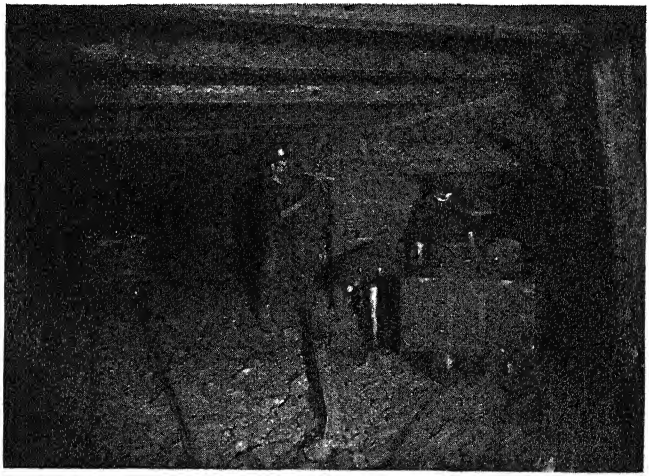
There are workmen engaged at the pit-head as well as down in the mine. Besides the enginemen and weighmen, there are the washers and sorters, whose work it is to wash, sort, and size the coal.

We think that the miners must long for the sunlight and the blue sky above them. But they are perfectly contented with their lot. "Use is second Nature" the old proverb says, and a boy born of mining parents probably enters the mine soon after he leaves school, and works in the mine all his life. Certainly the miners, as a class, have not the unhealthy look of many industrial workers, and it seems that the constant breathing of the coal-dust has very little harmful effect upon them. The greatest dangers of a miner's life are "falls" and explosions.

The former are large masses of coal which fall from the roof of the mine, and often crush the miner working beneath; the latter are due to *firedamp*. Firedamp is a highly explosive gas, which is frequently called *marsh gas*, because the latter often forms 99 per cent. of firedamp. For centuries this marsh gas, which was formed chiefly from decaying vegetation, has been pent up in the seams; it has no colour, taste, or smell, but when mixed with air it is one of the most explosive mixtures we have.

another fan, fixed in the sister shaft, extracts the foul air.

At last we reach a very narrow passage where the roof is much lower. Far away we hear a faint tapping noise, and we follow our guide along the black passage until we come to the "face" of the



[Photo, J Valentine

AT WORK IN A COAL SEAM

stall, where the miner is busily at work in winning the coal. His arms are very muscular, and he is stripped to his waist. Great lumps of coal are hewn out of the solid seam, and at times he drills holes in the coal-wall, inserts cartridges, and blasts the rock. After he has filled a truck, the "truckman" draws it off to the shaft, up which it is promptly hauled. It then runs on to a weighbridge, where its weight is carefully noted by the "weighman," and a numbered token is handed over so

CHAPTER V

IN THE VALE OF WEAVER

IT is not a long journey from a Staffordshire mining-village to the valley of the river Weaver, which flows through Cheshire into the Mersey estuary, and so we will visit this pretty little valley, for out of it comes something which is found in nearly every home.

One of the chief towns in the vale of Weaver is Northwich, which may be called the capital of Salt land. It does not need a plumb-line to tell us that many of the houses in Northwich are far from being upright, and we are not surprised to see some of them propped, or "shored," up by stout timbers. Many of the buildings are misshapen, with the doors sloping one way and the windows another. A builder would tell you that there was "sinkage," by which he would mean that the foundation on which the building was erected had sunk and, of course, the building had gone with it. In some houses the windows cannot be opened because the arch over the casement has dropped, and in others the tops of the doors have been planed from time to time in order that they may not scrape against the sinking lintels.

Deep down in the ground under these houses the miners have been at work hewing the brown rock-salt out of the salt mines. Rock-salt, like coal, is found in layers or seams, twenty or thirty yards thick. Just over two hundred years ago miners who were prospecting

for coal struck a salt bed, and Cheshire soon became the centre of a thriving trade in salt. The best known mine is the Marston Mine, near Northwich. It is about three hundred feet deep, and the miners enter it by a shaft which somewhat resembles an enormous well.

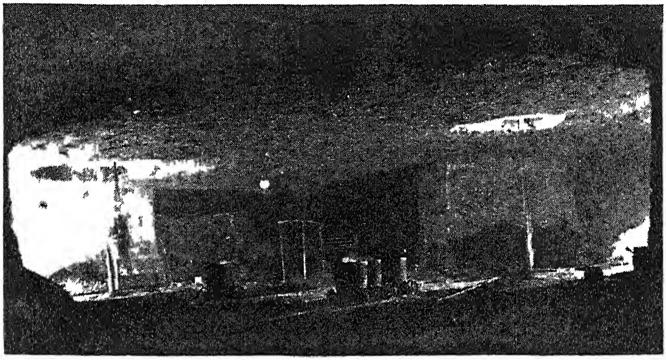
[Photo, J F Birtles, Warrington

SUBSIDENCE IN NORTHWICH

A visit to a salt mine is much more pleasant than a trip down a coal mine. Thick pillars of salt, twelve yards square, and standing at intervals of twenty-five yards, support the roof. Formerly the pillars were only five yards thick, and these were not strong enough to hold the earth above them, so that there was serious subsidence of land in many places. Dunkirk road, near Northwich, suffered severely in this respect, and a tall chimney-

stalk leaned over so much that many people thought it must fall.

Salt mining is a very healthy occupation, and there are few dangers now that substantial pillars are left to support the roof The air in a salt mine is pure and fresh, and the salt crystals sparkle and glitter in the light given by the lamps and candles almost like diamonds. The miners carry candles with them, and

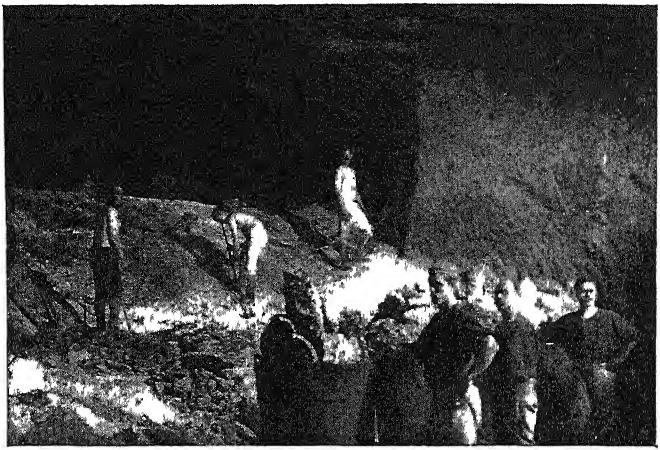


[*Photo, J E Birtles, Warrington*

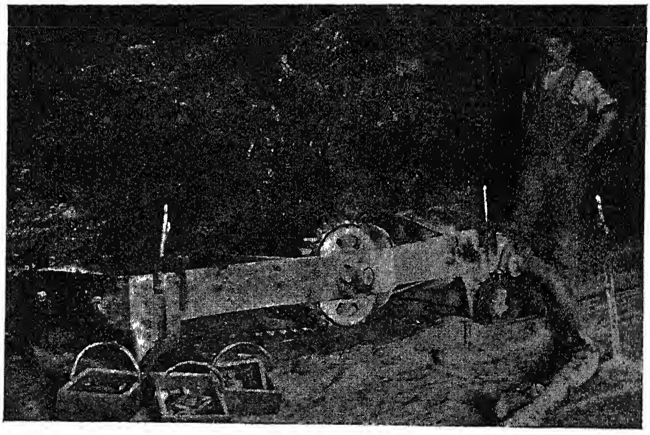
INTERIOR OF ROCK SALT MINE AT NORTHWICH ILLUMINATED BY ELECTRIC LIGHT

as there is no dangerous gas there is no fear of explosion. In some of the large mines there are stables for the horses which draw the tubs backward and forward along the workings. A tub can carry rock-salt weighing half a ton, and as one tub is drawn up the shaft by an engine, the other one goes down.

The methods employed by the miners in 'getting' the salt are very simple. A strong circular saw, called 'the cutter,' which is worked by compressed air, cuts into the solid bed of rock for a distance of about two feet,



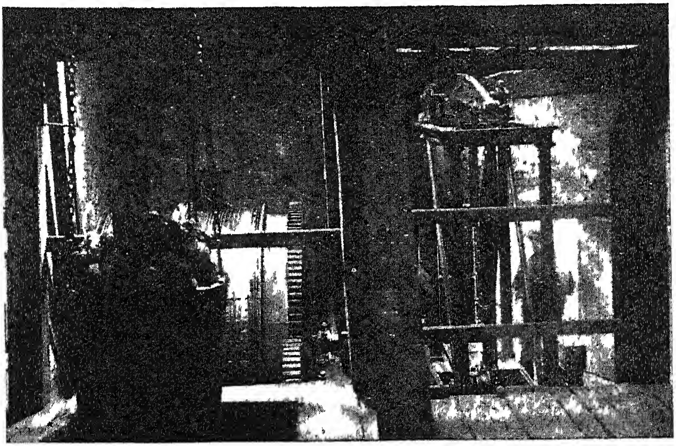
Loaded Tubs ready to be taken to the Shaft Bottom



'The Cutter,' driven by Compressed Air, used for cutting the Rock on the Ledges

and then the rock is 'blasted' To do this the miners drill holes three feet deep into the rock, and place about twelve ounces of powder in each hole. This powder is exploded, and the rock is shattered.

Rock-salt is used principally for cattle and for agricultural purposes, as well as in soda and ammonia works. The salt used for food is obtained from brine springs.



WINDING MACHINERY AT TOP OF SHAFT, WITH TUB OF ROCK-SALT

After the brine has been tapped it is pumped up into large iron pans open to the air, and heat is applied so that the water passes off as vapour, leaving the salt behind. If great heat is applied, so that evaporation is very rapid, the salt is of high quality and used chiefly as fine table-salt, but slow evaporation produces salt of coarser quality, which is used to cure fish and bacon, and in other trades. Sometimes water is pumped into the mine, and after staying

there long enough to become brine, it is pumped up again.

Improvements are constantly being made in the methods of 'firing' the brine-pans. Some manufacturers use gas instead of coal, and others boil the brine by steam.

After the table-salt has been dried it is packed, by girls, in cardboard boxes or paper bags, and shipped to all parts of the world. Most of the warehouses stand on the banks of the Weaver, or the Manchester Ship Canal, where ocean-going steamers come up to load.

CHAPTER VI

IN A WEST RIDING WOOLLEN TOWN

I WANT you to imagine a vast, bustling manufacturing town, containing scores of massive warehouses bordering cobbled roadways, along which puffing traction-engines and lumbering lorries rumble all day and part of the night too, and down which stream thousands of men, women, and girls on their way to and from the gloomy-looking factories.

This is a brief pen-picture of a typical Yorkshire woollen town. Let us pay a visit to busy Bradford, one of the largest towns in the service of King Wool, and see the woolworkers at their daily tasks. Bradford has no special charm for the tourist in search of picturesque scenery. Many of its buildings in the industrial quarters of the city look as if they have become old before their time. The town lies in a hollow, and fog and smoke hang over it like a gloomy pall most of the winter-time. Consequently the warehouses have a drab, dreary appearance ; the gateways could do with a coat of paint ; and the constant clatter of heavily-laden wagons passing up and down the rough narrow streets almost deafens the visitor.

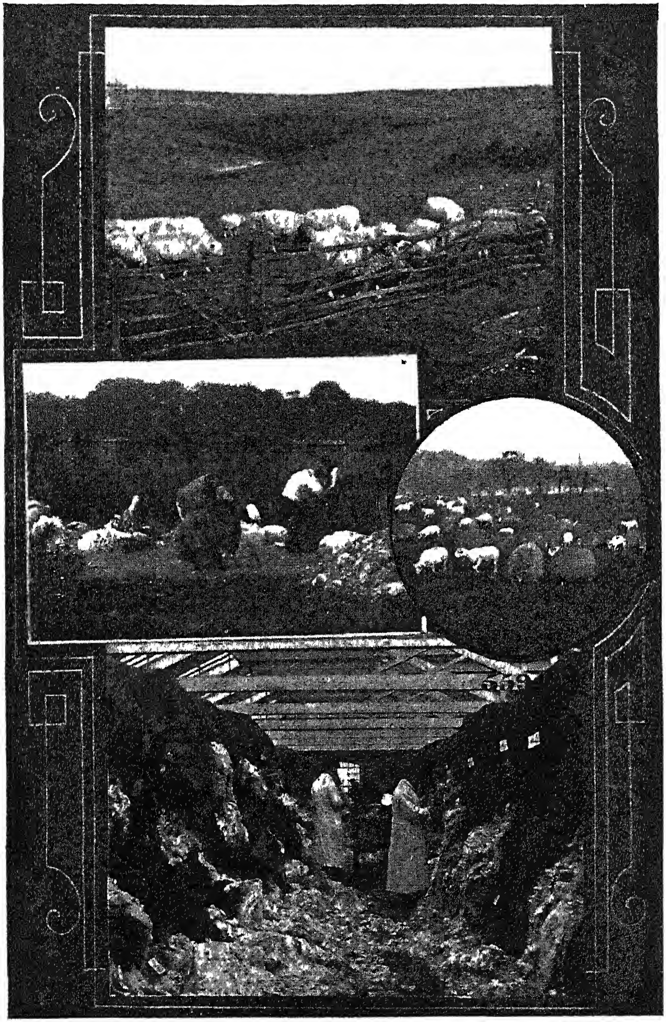
Away up on the heights are dozens of little villages, where many of the woolworkers live in small brick-built houses, standing in long even rows. Before these villages were built the country-side was picturesque and,

in some parts, charming; for Yorkshire scenery is noted for these qualities. All the winds of heaven sweep down from mountain and moor to invigorate these weary woolworkers, and restore some of the colour to their faces made pallid by the hot, unhealthy atmosphere of the factory.

Let us stand in one of these villages at about half-past five on a summer morning. Out of nearly every house come women, girls, and a few men on their way to the tramcars which quickly carry them down to the mills. Sirens shriek and hooters hoot, and late-comers rush pell-mell to the cars, for if they are late they will find the huge gates of the factory turned against them. Many of them carry small tin cans or vacuum flasks in their hands, for they will not come home till nightfall, and will take their hurried meals inside the factory. As the women enter some of the yards, maybe their husbands, brothers, and sweethearts are leaving by others, for there are many night-workers in the mills, all of whom are men, as the law forbids women to work at night.

During the day-time the village is very quiet. The tiny tots are in the charge of their big brothers or sisters, the men folk are in bed, and the big boys are at work in the mill, for, at the time of writing this book, the disastrous half-time system is still in force, and the weary boys will look at their teachers with drowsy eyes and nodding heads in the afternoon. At breakfast and dinner-time a few of the workers hasten home, but in most villages the mills are too far away for these meals to be taken at home.

At six o'clock in the evening the reverse order of things is to be seen; the men are going to work and their wives and children are returning home. In scores of Yorkshire



SHEEP GRAZING
SHEEP SHEARING SHEEP, SHORN AND UNSHORN
A WOOL WAREHOUSE

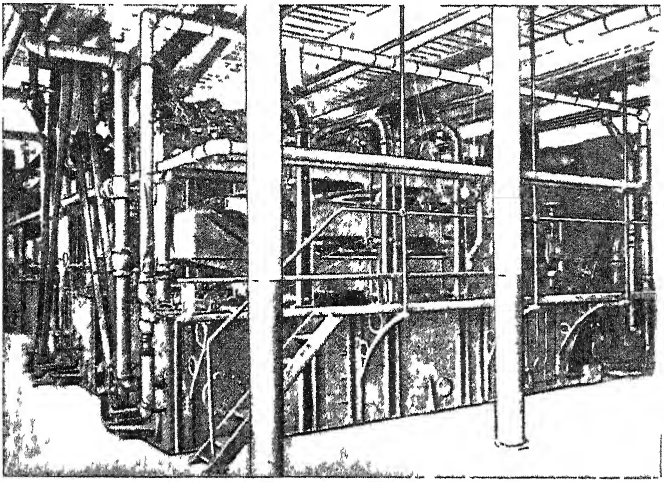
homes husband and wife see very little of each other except on Sundays. Several of the woolworkers have large families, and mother, in addition to her arduous day's work by the spinning-machine, has to look after the bairns, and tidy the house at night.

From this you will think that the Yorkshire woolworkers have very strenuous lives, and you will not be mistaken. Those of you who live your quiet orderly lives in rural England, and who are fortunate enough to have mothers who are able to give their whole time to housekeeping, cannot imagine some of the hardships many of the little Yorkshire boys and girls have to endure. These little folk have to 'fend for themselves,' as we say, and most of them, having a great deal of responsibility thrust upon them, are old beyond their years. Some of the boys can turn their hands to cooking quite as well as any girl, and there are few household duties that they cannot undertake. As a rule the West Riding boys are very quick-witted and trustworthy. It is a great pity that they have to go into the mills so early in life, for the stifling atmosphere and congested 'sheds' impair their health and hinder their growth.

There are many stages in the manufacture of wool from the shearing of the sheep's fleece to the completion of the woollen fabric. The preliminary work of sheep-shearing and wool-washing is usually done thousands of miles away from Yorkshire, in distant Australia, New Zealand, and South Africa. The wide, rolling pastures of these countries are admirably suited to sheep-rearing, and most of our raw wool comes from Australia. In the earliest days of the woollen manufacture the wool from English sheep was sufficient to meet all requirements, but the trade has grown so enormously that we

have long since had to look to other countries for our supply.

To describe fully all the stages of the woollen manufacture would require a book many times larger than this. The two main operations are Spinning—which includes the preparatory work of sorting, washing, dyeing,

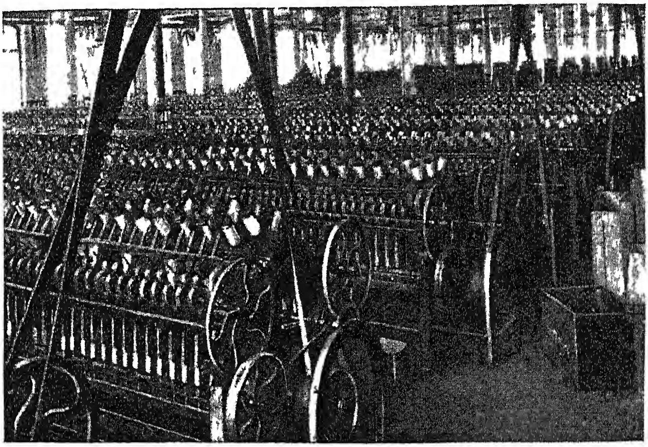


WASHING ROOM
From "Textiles," by W. H. Dooly

carding, and combing—and Weaving. The 'sheds' containing the spinning-machines are very long and narrow, and thousands of wheels cause the whizzing rows of spindles to twist the yarn into the necessary thickness. The majority of the spinners are girls. They have to watch the spindles, and when a thread breaks they have to mend it. You can imagine that they are very busily employed, for the yarn is frail, and the spindles revolve

five or six thousand times in a minute. Each girl has a certain space allotted to her, and her attention has to be directed to scores of threads at the same time. The boys have to see that the spinning-frames are kept well supplied with full bobbins.

The spun yarn is taken to the weaving-shed, where it

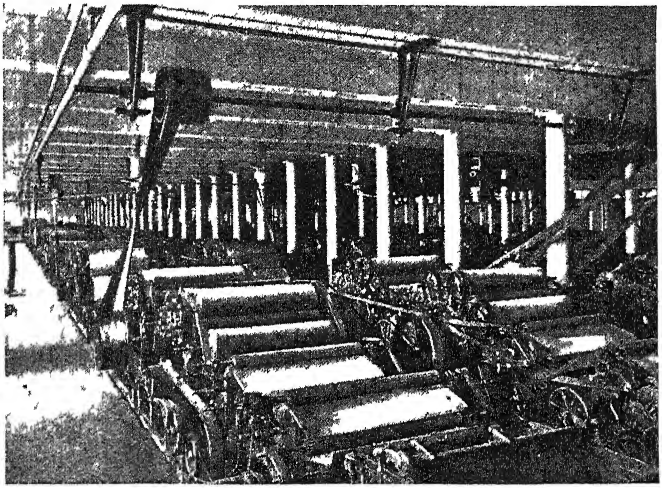


WORSTED SPINNING
From "Textiles," by W. H. Dooley

is woven on the loom into fabrics of all manner of patterns. Many women work at the looms. There is even greater noise in a weaving-shed than in a spinning-room. Hour after hour the pulsating machines rattle and clatter; the shuttles fly to and fro, threading their way in between warp and woof with unerring rapidity; the threads are mended; and the intricate machines carefully watched to see that the shuttles are performing their work, and that the criss-cross designs are being made in the proper

order. All kinds of cloth are formed under the watchful eyes of these women, and many of the clothes which we wear have once been handled by them.

For many years certain towns have given special



CARD ROOM

From "Textiles, by W H Dooley

attention to one kind of woollen article. Thus Saltaire, near Bradford, is especially noted for Alpaca cloth, which was manufactured first by Sir Titus Salt, from whom the town takes its name. Newton and Welshpool in Wales, and Rochdale in Lancashire, are noted for flannel, and Halifax and Dewsbury are famed for their carpets.

CHAPTER VII

IN A SHIPBUILDING YARD

QUITE one of the most important British industries is that of shipbuilding, and it would be highly interesting and instructive to walk round a large shipbuilding yard.

The British shipping industry may be roughly divided into two main divisions, one of which is the construction of battleships and minor war-vessels; and the other, the building of our vast merchant fleet and liners. For centuries we have been famed all over the world for the skill displayed by our shipmasters, and for their rapidity in constructing vessels of offence and defence. Britain has long been the mistress of the seas; her ships enter every port of the world, and all the ocean trade routes are crossed and recrossed by our liners and merchantmen. It is, therefore, not surprising that we have made a speciality of shipbuilding, for our commercial life depends almost entirely on the trade we carry on with countries across the sea.

Just think for a moment what would happen if all the world's shipping were suddenly held up. One of the most serious consequences to Englishmen would be that we should soon be at the point of starvation. Immense stores of wheat and other food supplies arrive day by day in our great ports, and if these were stopped, the reserve stores in our warehouses and shops would speedily disappear. No food-stores can come into the British

The Walker Shipyard, Newcastle-on-Tyne (Sir W. G. Armstrong, Whitworth & Co., Ltd.), showing six berths occupied by ships in various stages of construction

Isles except by water, and our teeming millions would find it hard to support life if no imports arrived.

Another very serious disaster would be the large amount of distress through lack of employment. Just when food prices were rising by leaps and bounds the workers in our large factories would be earning little or no money. Many of our huge mills, such as the cotton mills of Lancashire and the woollen mills of Yorkshire, would cease working if the raw supplies of cotton and wool were withheld. Indeed, it is hard to realize the serious menace to our life as a nation if no ships could enter or leave the docks for a few weeks.

Probably there is no noisier place in the country than the stocks of a shipbuilding yard when a vessel is having the great steel plates riveted on its sides. Town-dwellers may have some idea of riveting by watching men driving red-hot rivets through holes in plates which join two lengths of tram-line. You have seen a boy holding a short piece of iron, which resembles a very big round nail, in a fire which he occasionally blows up with bellows, and, at a signal from the riveters, take the rivet out of the fire with tongs, and hand it to one of the men. This man inserts it into the edge of the hole which passes through the plate, and two strong men, wielding heavy hammers, force it through the hole and afterward hammer the projecting end flat up to the plate so that the rivet has two heads. No one could possibly pull a rivet out of a steel plate as a nail is pulled out of wood; once the rivet is driven in, and a second head is made to it, it is there for all time.

You know that the men laying the tram-lines make a great din, but this is as nothing to the deafening roar which hundreds of riveters, working at the same time,

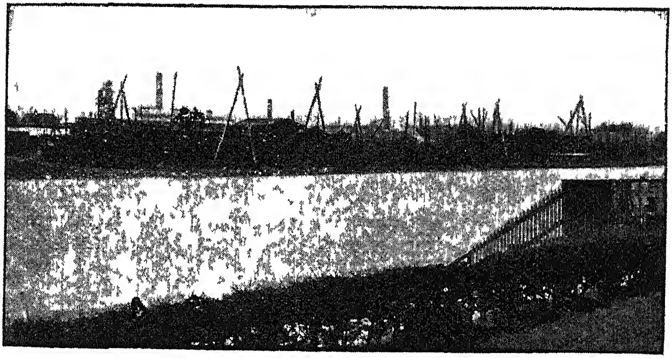
make on a hollow vessel. Day and night the noise goes on. In certain workshops the men are punching holes in the steel plates ready for the riveters ; other workmen are bending enormous steel frames ; carpenters, joiners, upholsterers, plumbers, blacksmiths, and workmen representing dozens of other trades all have their special work to do, and a shipyard is a scene of great bustle and activity. Enormous cranes and derricks are lifted up in all directions ; steam-hammers are brought down upon masses of iron and hammer them into thin plates ; and, in some parts, the yard resembles a miniature iron-works.

It takes many months to build a big ship. Some of our liners are fitted with most luxurious saloons, and resemble floating hotels, and there are hundreds of cabins on each vessel. When you consider that one liner is able to carry more people than there are in a large village, you will realize that many rooms are wanted, and that the ship is of great length.

All our shipyards are close to the sea or on the estuaries of rivers, for a large completed ship could not be carried over land to be launched in the sea. The dry-dock in which the ship is built generally slopes down to the water, and the vessel rests on enormous blocks of timber. When the ship is launched it slides down these blocks into the water.

The chief British shipbuilding yards, where ships of all kinds are constructed, are the Clyde, Belfast, Jarrow, Tynemouth, North Shields, South Shields, Sunderland, Hull, Stockton, Barrow-in-Furness, London, Birkenhead, and Bristol. Our naval dockyards, where war-ships are built, are Chatham, Portsmouth, Devonport, and Pembroke, although, of late years, many war-vessels have been constructed at Barrow and Birkenhead.

It is only about a hundred years ago that the first steam-propelled boat, built by Henry Bell, was launched on the Clyde. Before that time only sailing-vessels had been in use. You may have seen pictures of the old schooners and brigs becalmed in the middle of the ocean, or beating up laboriously against the wind. Bell's invention revolutionized the shipping industry. So successful was the little *Comet* that other shipmasters



[*Photo, J. Valentine*

ON THE CLYDE AT RENFREW

built steamers, and, step by step, the old sailing-vessels were replaced by steamships. At first, all people did not take kindly to the new craft. Tea-merchants said that the steam and fumes from the engine spoiled their cargo, and so would use only brigs and schooners; fruit-merchants who imported fruit from foreign countries held a similar belief, and steamers were not wanted by them either. But in time the adoption of steam-propelled vessels was universal. Soon there were hundreds of steam-colliers plying between London and Newcastle,

and Cardiff and the Continent; grain steamers conveyed corn from the Black Sea and America to London and Liverpool; cotton schooners were replaced by steamships; and now in nearly every port steam-vessels are vastly more numerous than sailing-ships.

The modern battleship is one of the most ugly ships constructed, and it lacks the graceful lines and delicate proportions of the great liner. A Dreadnought has been admirably described as "a raft built up of steel plates, and raised high out of the water; less than two hundred yards long, barely thirty yards in breadth, and narrowing at the end. On the top of the raft are ten guns, set in pairs along the centre line, and over each pair is a low protective dome of metal. Only the protruding muzzles of the guns can be seen. There is little else to arrest the attention, except two dwarf funnels like truncated factory chimneys, and a structure formed of two huge steel pipes, resembling a half-made crane, and serving apparently as a mast. . . Her lines are hard and harsh; her colour drab and insignificant; even in size she is not remarkable."

"Use, not ornament," has evidently been the motto in the building of a battleship. The most clever naval scientists and engineers in the world have planned her lines and armed her with those terrible guns. Well may she be named the *dread-nought*, for those huge guns are the finest the world has yet produced, and all smaller hostile ships which come within their range will meet with a merciless doom in time of war! It is estimated that her huge shells, travelling at a speed of over 2000 feet in a second, are able in a clear day to wreck anything within a range of five miles.

If you were fortunate enough to go over one of these terrible monsters you would get some idea of the immense

labour and care which were required in her construction. Thousands of men have been employed on her, day and night, for over two years. Scores of factories have contributed to her needs. Yet Britain has such magnificent naval dockyards, and such clever shipbuilders, that we are able to complete a Dreadnought several months quicker than our greatest rivals.

The cost of our modern battleships and their expensive equipment is extremely heavy, and for many years it has been a great strain on British taxpayers to meet the demands of the navy. At the present time there is disastrous rivalry between certain nations over the production of battleships. Our statesmen have, on several occasions, suggested means whereby this rivalry could be stopped, but so far their suggestions have not met with success. Every year we are compelled to lay down five or six of these monsters so that we may keep ahead of our rivals, because Britons recognize that their safety as a nation depends almost entirely on having a more powerful navy than any of their neighbours.

CHAPTER VIII

A MODEL INDUSTRIAL VILLAGE

In most of our wanderings through Industrial England we have noticed that the dwellings of the workers are very incommodious and inartistic. We have remarked on the dreary monotony of row after row of two-storied, red-bricked, and slate-roofed houses, each having but a tiny flagged forecourt and a small back garden.

Sir William Lever, however, the founder and head of the great Sunlight Soap Works, has had ideals which we find realized in the charming and healthful garden city at Port Sunlight.

The original soap-works stood at Warrington in Cheshire, and at first the output was only twenty tons of soap a week. Gradually this increased to four hundred and fifty tons weekly, and Mr Lever looked out for some "rural district where ample acreage could be secured adjacent to both rail and water transport, with reasonable facilities for obtaining the necessary supply of labour." The position ultimately chosen was on a peninsula formed by the estuaries of the Mersey and the Dee, not far from Birkenhead, the great shipbuilding centre.

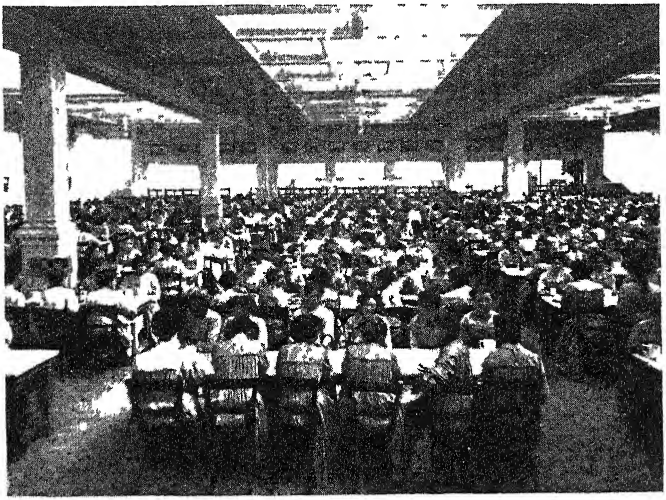
At first fifty-six acres of land were purchased, twenty-four of which were used for the works, and thirty-two for the village of Port Sunlight. Soon about eight hundred tons of soap were turned out in a week, but the business continued to grow so rapidly that, at the present time,

there are four soaperies capable of producing weekly 4,000 tons, and about ninety-six acres are occupied by the factories, wharves, and sidings. Port Sunlight, which includes the village, with recreation ground, a free library, allotments, etc., now covers an area of 231 acres, of which one hundred and thirty-five are used for houses, gardens, village institutions, and open spaces. In all there are nearly eight hundred houses.

The following description of the plan on which this model village was built is quoted, with but slight alteration, from Sir William Lever. "In planning the houses the idea has been first to provide a garden as foreground to the cottage and screen from the road. These front gardens are in every case kept in proper order and cared for by ourselves. . . . This care by ourselves of front gardens is effected at a cost of threepence per garden per week. In addition to these front gardens we have also allotment gardens to almost each block of cottages. These allotments the tenants cultivate themselves as vegetable gardens, or, properly fenced, are used for poultry, etc. They are placed as near as possible to each cottage, and are the very safety valve of the village. . . . The accommodation in the cottage type provides for three bedrooms upstairs, and living room, kitchen, scullery, bathroom and larder on the ground floor, with enclosed yard, and usual outbuildings. The parlour cottages differ from the ordinary cottages in having an additional bedroom on the first floor and a parlour on the ground floor."

The population of Port Sunlight is about 3,600, and the wide roads and open spaces make the district very healthy. This little town contains, in addition to the soaperies, commodious docks and warehouses; Power

Houses for the generation of electricity; a Printing Works, where are installed seventy machines, from the hand press to the latest electric rotary machines; a cardbox factory containing machinery for wire-stitching and glueing the boxes and giving them a metal edge; and a boiler-house which has ninety huge boilers fitted with mechanical stokers.



GIRLS AT DINNER IN SUNLIGHT SOAP WORKS

The social side of the workers' lives is not neglected, and the old saying: "All work and no play makes Jack a dull boy," was evidently borne in mind when the village was supplied with a fine Tennis Lawn, Gymnasium, Bowling-green, Football and Cricket field, Open-air Swimming Baths, Cinematograph Hall, and Social Clubs. That the workers may not neglect their education, a Technical

Institute has been built, together with a Free Library, and various Halls are used for dramatic and musical entertainments.

The boys and girls have two fine picturesque schools with lofty, bright, and airy classrooms, and there are about 1400 children in attendance. In connexion with the village church there is a Boys' Brigade. Living in such a healthy, bright district, with spacious gardens all about them, the children are ardent little gardeners, and at the Annual Flower Show their exhibits of flowers, etc., are among the most interesting in the display.

It would be well for Industrial England if all the workers were able to live among such healthy surroundings, but, unfortunately, in many cases space will not allow of model villages being erected. Of late years steps have been taken all over the country to improve workmen's dwellings, and it is hoped that in a few years' time there will be such great improvement in the social and recreative side of the workers' lives that it will in a measure compensate them for the often dreary, unhealthy surroundings where their daily toil is carried on.

The raw materials used in the manufacture of soap are oils, fats, resin, and alkalies, and it is through the action of an alkali on various fats and oils that soap is produced. All fats, and many forms of oils, are capable of being separated into glycerine and substances known as fatty acids. The alkalies, the chief of which is a solution of soda known as 'Caustic Soda Lye,' have power to detach the fatty acids from the glycerine, and, in combination with the former, they produce the compound which we call soap. The action of Caustic Soda on fat produces *hard* soap, while the action of Potash yields *soft* soap.

A visit to the spacious wharf will give an idea of the many thousands of casks of oil and tallow used in the factory.

As soon as the various oils, fats, alkalies, and resins have been prepared the actual process of soap-making

SUNLIGHT SOAP PACKING. GIRLS PROTECTED BY OVERALLS PROVIDED BY THE FIRM

begins. For an account of this we cannot do better than read Messrs Lever's own description :

"The soap-boiling pans are square, and have each a capacity for boiling 60 tons of soap. Successive portions of melted fat and caustic soda liquor are run into the pan and boiled with steam. As soon as all the fat has been converted into soap, the glycerine water which has been at the same time produced is separated from the

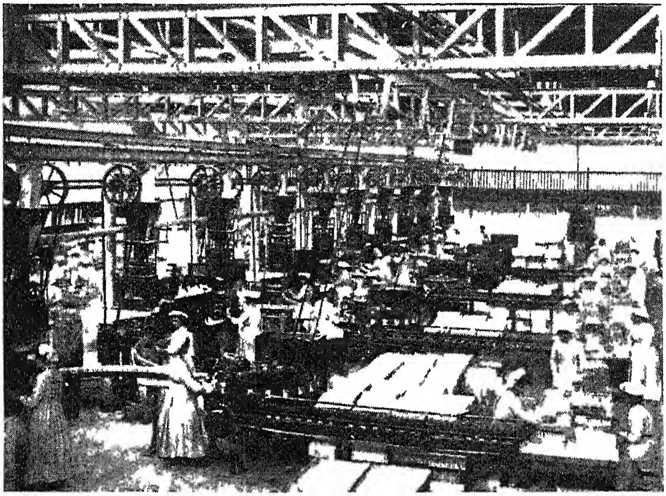
soapy mass by the help of common salt. The salt is thrown into the pans and by its action the soap rises to the surface in the form of a curd, the glycerine water and all impurities being left at the bottom of the pan. Then, the 'spent lyes,' as they are called, are drawn off, and after about a week's work, the pure soap is run off into the 'cooling frames,' a little perfume being mixed with it on the way. This perfuming process is, of course, distinct from that which is employed in the manufacture of toilet soap. When perfumed, the soap flows to a lower story into the iron cooling frames. The ends and sides of these frames are held together by clamps, so that when the soap is cold (in from 5 to 6 days, according to the time of the year) the sides and ends can be removed, leaving a block of soap weighing about 15 cwt., ready for cutting up.

. . . . . .

"The soap, when released from the frames, is first cut into slabs by 'slabbing machines' furnished with transverse parallel wires. These, drawn through the block, leave it cut into slabs of the required thickness. The slabs are conveyed next to a 'barring' machine, with a cutter worked by a lever frame on which are strong vertical wires. The slab is placed lengthwise and nearly upright upon the base-board of the machine and the lever frame drawn through it. The bars thus formed fall back upon the shelf behind, whence they are removed and piled across each other in such a way as to allow a free circulation of air through the piles.

"After standing a day or two, the bars are again cut into shorter bars of the required length to which the tablets are to be made. The short bars are next stamped with the name or quality of the soap, and the name of the

manufacturer. The stamping is done by machines under the care of girls. The nimble fingers of girls fold the stamped tablets in printed wrappers, giving directions how to use the soap to advantage. The wrapped tablets are placed in cardboard boxes printed in several colours, and pass next to the packers, by whom they are swiftly



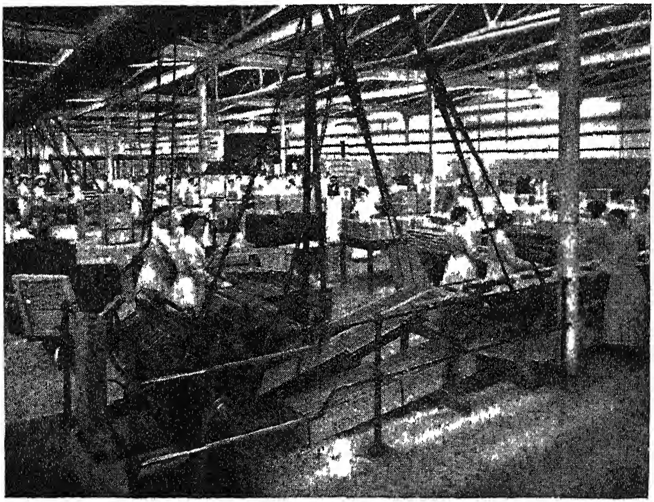
LUX PACKING BY MACHINERY GIRLS PROTECTED FROM DUST

placed in the wooden cases in which the soap makes its appearance before the grocer or storekeeper."

Among the purest materials used in soapmaking are Coco-nut and Palm Kernel Oil, obtained by Lever Brothers from the Belgian Congo, the British Solomon Isles and other oil-palm bearing regions.

The trunk of the coco-nut palm rises like a slender column to a height of from seventy to ninety feet, and is

crowned with the fruit and with graceful, curved leaves, resembling immense feathers. The fruits are about the size of a man's head and are borne in clusters at the bases of the leaf-stalks. The ripe coco-nut has a green fibrous husk, about two inches thick, enclosing



LIFEBUOY SOAP. STAMPING AND PACKING

the hard, bony shell of the nut, which is of a brown colour and is capable of taking a polish. The natives remove this outer husk by striking it on the point of a crowbar placed upright in the ground. The nut is then cracked, and the white kernel cut out and placed in the sun to dry.

The pulp of the coco-nut, when dried, is called 'copra.' From the fresh coco-nut pulp or from the dried 'copra'

the oil is extracted either by means of a solvent or by pressure.

Other important oils used are Olive Oil, from Southern Europe, Northern Africa, Western Asia, Australia and California; Ground-nut Oil, prepared from the pea-nut which grows in sub-tropical countries; Linseed Oil, obtained from the seed of the flax plant, and used principally in the manufacture of soft soap; Cotton-seed Oil, which comes from the seed of the cotton-boll; Soya Bean Oil, a recent importation which is derived from the Soya Bean of China and Japan, and Palm Oil. The following description of the preparation of Palm Oil by the natives of Western Africa is taken from a book issued by Messrs Lever:

"The fruit-clusters, when ripe, are cut from the tree, and exposed to the action of the sun and air for from seven to ten days. This loosens the fruits from the stalks, and so allows them to be readily detached by beating. The fruits are next freed from the husks that adhere to their bases, either by hand-picking, or by rubbing them together and then throwing them in the air, so that a strong breeze may blow away the separated husks. They are then buried in a hole about four feet deep lined with plantain leaves, and covered over with leaves and earth. In a short time, varying from three weeks to three months, decomposition causes the fleshy portion of the fruit to become pulpy as though it had been thoroughly boiled. The fruits are then placed in a hole paved with rough stones, and pounded with wooden pestles until the pulp is quite removed from the hard nut. The whole mass is next removed from the hole, the nuts taken out, and the pulp placed in a pot with a small quantity of water and heated over a good fire until the

oil begins to separate. The pulp is then placed in a rough net open at both ends, to which are attached two or three short sticks, by turning which in opposite directions the oil is squeezed out and runs into a tub or other receiver. The nuts, which have been separated from the pulp in the process of preparing Palm Oil as described above, are put in the sun to dry. If broken after being well dried, the kernels are obtained in a more perfect condition."

CHAPTER IX

IN THE LAND OF CLOGS AND COTTON

NOT far from the great soap works of Messrs Lever Brothers at Port Sunlight is Manchester, one of the largest and most important trading-centres in England.

What a vast hive of industry is this part of the country! As we walk about Oldham, Bolton, Preston, Blackburn, Barnley, Accrington, Wigan, Bury and Rochdale, we find massive warehouses with dark and forbidding walls frowning overhead, and along the cobbled roadways we pass lumbering lorries piled high with bales of cotton. Should we be waiting at one of the entrances to the yards at meal-time we should see crowds of men and women and boys and girls streaming along the congested thoroughfares on their way home. If it be night, and the day's work is over, there will be a tired, strained look upon their faces, and there seems to be no time for conversation.

We should certainly not expect to find very picturesque scenery in a cotton town. There is a dreary drabness about the streets in the industrial quarters, but, like most manufacturing towns, there is a 'West' end and an 'East' end. In the shopping centres of Manchester and Blackburn one may see luxurious motor-cars and well-dressed ladies and gentlemen thronging the brightly lighted streets, just as we may see similar scenes in Regent Street and Oxford Street in London. There is

an enormous contrast, however, between the grand hotels, attractive cafés, gorgeous arcades, and enticing shops of the commercial part of the city, and the massive mills, for ever overhung with a pall of smoke, in the industrial parts.

A visitor from the South coming to Lancashire for the first time would at once remark the rattle and clatter of the clogs along the streets. Perhaps he has seen a pair of clogs, and has imagined that, as the sole is made of hard wood shod with a narrow strip of iron, and therefore without 'give' in it, the wearers must have painful corns and aching feet. Probably he thinks that it is just custom, and nothing else, which compels the Lancashire lads and lassies to use this form of footwear, and in his heart he feels pity for them.

But this is an entirely wrong impression. The clog is exceedingly popular among the working classes of Lancashire. It is cheap, comfortable, and warm, and however wet the streets may be, it will not let in water, as will much-worn leather soles. Thus we find that clogs are not only worn by Lancashire people, but by tanners, and other people who have to work in damp and wet places. The children go to school in clogs, and their mothers and fathers wear clogs about their homes and at work in the mills. In many mills the clogs are taken off in the various factories, and the workmen walk about barefoot. As a rule, the clogs are discarded in favour of ordinary boots and shoes when their wearers go to church and chapel on Sundays, but directly the people have returned home, the boots and shoes are taken off, and the well-worn old factory clogs are slipped on.

Perhaps my readers in the South imagine that the clogs are never cleaned. This is by no means the case;

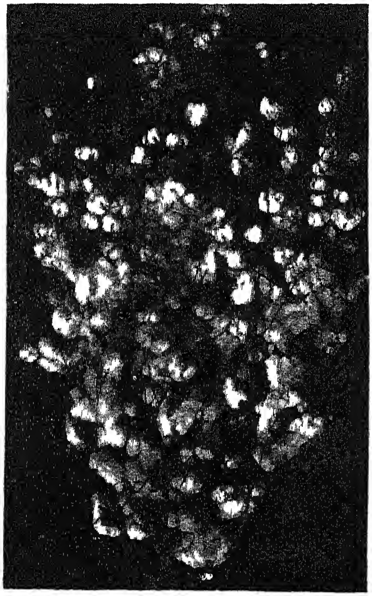
the Lancashire lass takes great pride in burnishing the upper leather and in washing the wooden sole. She may have tousled hair, patched shawl, and buttonless blouse, but she *must* have clean clogs. The smartest dressed lass in the mill would be reprimanded if she went to work in dirty clogs.

The clogs are of many shapes and designs. Some people prefer light clogs with a very thin iron sole; others favour clogs with a heavy strip of iron running right round the soles, and these will last as long as two or three pairs of leather boots. Most of the women's clogs are low-cut like a pair of shoes or slippers, but the men's are usually 'lace-ups.' In some cases the leather is marked with curious patterns, but usually there is no ornamentation.

There are many branches of the cotton industry, and nearly always a man keeps to one special branch, so that he probably knows little or nothing of the work of his mate in a neighbouring factory. The chief cotton 'trades' are those followed by the spinner, the weaver, the bleacher, the dyer, and the printer. Strange to say, too, the towns specialize each in a different trade; thus Burnley, Blackburn and Preston are noted chiefly for cotton *weaving*, while Oldham and Bolton are specially engaged in cotton *spinning*. Manchester is the great warehouse and distributing centre of the cotton, for most of the raw cotton passes through Manchester on its way to the towns around, and a great deal of the manufactured cotton and cotton goods are collected by Manchester and dispatched to all parts of the world. From this it must not be thought that Manchester has no textile factories of her own; there are cotton-mills and all kinds of textile machinery in this town, but it is concerned

mainly with importing and exporting the cotton, and it may be well described as the 'clearing-house of the cotton industry.'

Let us now briefly trace the different stages in the manufacture of cotton, from the raw cotton, growing under the warm southern skies in Alabama and the neighbouring States, to the cotton frocks and blouses worn by many girls in summer, or the lace and muslin curtains which decorate our windows.

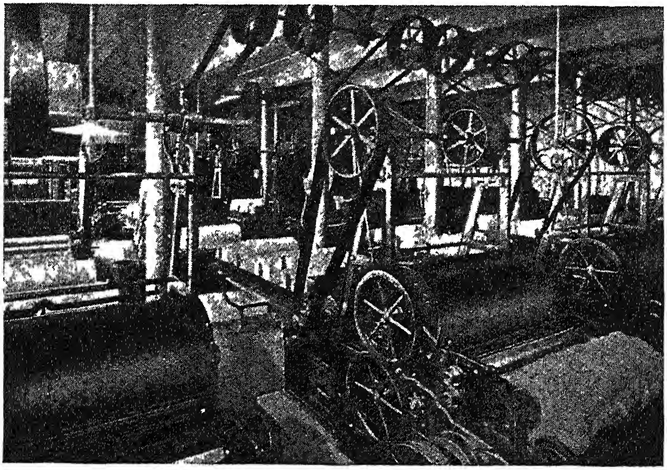


COTTON BUSH
From "Textiles," by W. H. Dooley

The cotton plant is a short, bush-like tree, which bears numerous pods, and, when mature, these pods burst open and disclose a downy, wool-like substance which envelopes the seeds. The pods are known as *bolls*, and a field of ripening bolls, covering hundreds and hundreds of acres of land, is a beautiful sight, especially when the woolly fibre sways backward and forward in the breeze.

The chief cotton-producing districts are the Southern States of North America, bordering the Gulf of Mexico, and watered by the River Mississippi and its tributaries; the West Indies; Egypt; India and China. The output

of cotton from Egypt is gradually increasing, and Parliament will probably make a substantial grant to Egypt, in order that the Egyptians may still further develop the growth of cotton in their country. Our cotton manufacturers look with favour upon this grant, as year by year there is an increasing demand for American-grown



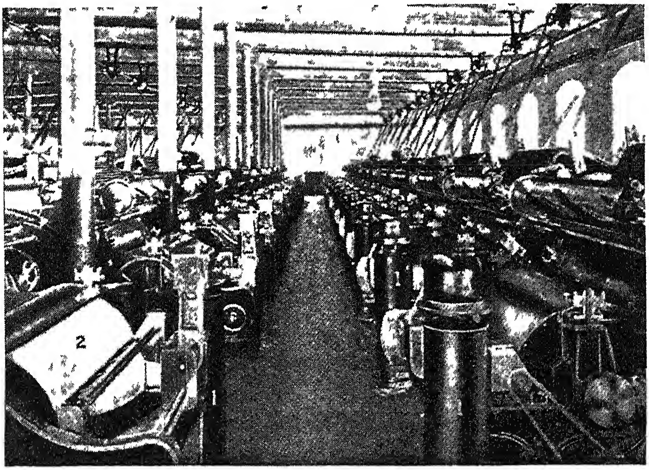
PICKER ROOM, SHOWING END VIEW OF PICKER
From "Textiles," by W H Dooley

cotton by the American manufacturers, and it is thought that in a few years we shall be unable to depend upon America for our supply of raw material. The very best fibre comes from the West Indies.

As a rule, negroes are employed by American cotton-planters to pick the fibre After the fibre has passed through the ginning-machine, which extracts the seeds from the fleecy bolls, it is packed by the balling-press into large bales, each weighing from 300 to 400 lbs. The

bales are covered with coarse canvas, hooped with iron, and are stored away in the vast hold of a cotton-ship.

After a long voyage the bales arrive at the factory and are broken open. The matted fibre is then freed from lumps by the willow This is a revolving machine which is furnished with spikes, and these rend the lumps into small



CARD ROOM

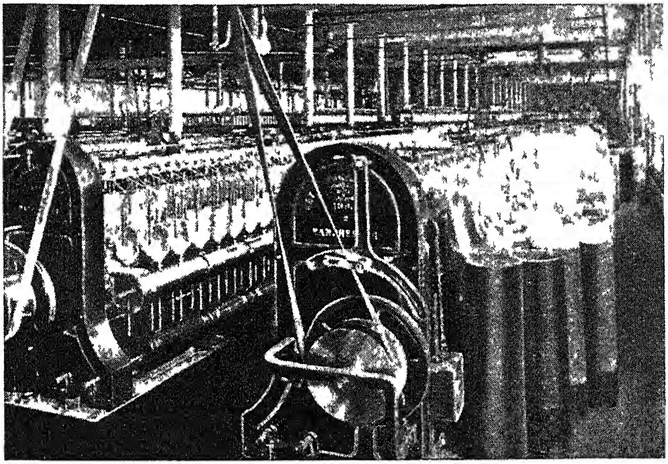
1 Roving Can—Receptacle to hold the sliver
2 Cylinder of the card (the cotton is on this cylinder in the form of a web)

From "Textiles," by W H Dooley

pieces, and also partly clean it by shaking out some of the dust

The clean fibre is then taken to the carding room. At present the fibres are not arranged in any order ; they cross and interlace each other, and it is the work of the carding-machine to arrange the fibres in a continuous sheet or web, known as the *lap* Another process forms the web into a thin cord called a *sliver.*

There are many other processes to be gone through, the chief of which are *roving*, which draws out and twists the fibres, *singling*, or twisting two strands of yarn into one thread; *doubling*, where several strands are twisted into one thread, *reeling*, where the yarn is made into



ROVING DEPARTMENT

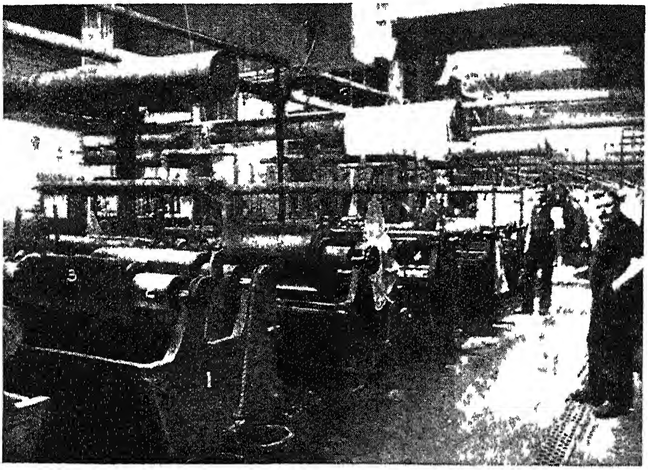
Slubber machine, showing sliver of cotton passing through the rolls and then given a twist while it is wound on the bobbin

From 'Textiles' by W H Dooley

hanks, each hank being about 1,800 yards long when drawn out, *spooling*, where the thread is wound by bobbins; *bleaching*, *dyeing*, and *weaving* To describe fully all these processes would require a book much larger than this. In Lancashire the cotton is spun almost entirely by men and boys, but in Yorkshire the spinning-machines are worked chiefly by women and girls

It is a wonderful sight to see row after row of spinning-

machines at work. How quickly the boys dodge in and out between the whizzing, whirring spindles, removing the empty bobbins from the long steel frames of the spinning-machines and replacing them with full bobbins. Now and then a thread will snap, as the fibre is very frail.



Dye Room

1 Tub or vat containing dye stuffs
2 Rolls or cylinders upon which cloth is wound
3 Cloth leaving dye tub.

From "Textiles," by W H. Dooley

Indeed, you wonder that those ponderous machines, stretching in apparently never-ending rows, do not break all the delicate threads. The boys have to watch for a 'break,' and it is immediately mended.

If you are interested in the cotton manufacture you should read about the early inventors of the spinning-machine. The life-stories of Hargreaves, Arkwright, and Crompton are most interesting and romantic. There

seems to be no comparison between the humble little spinning-jenny invented by Hargreaves and the elaborate and complicated machines to be seen in the mills of Lancashire at the present day. But we must remember that these men were the pioneers of the industry. Before their time there were no large factories. The fibre was spun in olden times by the aid of the distaff and spindle. The coming of machinery revolutionized the cotton industry; the machine could do the work of many pairs of hands, and though the manufacturers were glad, the poorer people were very angry with the inventors, and they wrecked the machines and drove the inventors out of the district.

All is bustle and activity nowadays in a cotton mill. The remorseless machines, ever whirring and clanking, are greedy monsters, and their attendants almost become machines too, so mechanically do they perform their work. Each man and boy has his appointed task, and while the machines are running he knows little of anything which is going on elsewhere. At times the boys squat down on empty bobbin-baskets, but they fly with lightning-like rapidity to the long frames when the bobbins are empty.

A cotton boll has to go through scores of different machines before it becomes part of the fabric which dressmakers make up into a cotton blouse, and hundreds of thousands of people are employed in the cotton manufacture. Schoolboys are allowed to work in the mills in the morning and attend school in the afternoon. One cannot wonder at the poor half-timers occasionally dropping off to sleep over their books, as there is an enormous contrast between the quiet schoolroom and the noisy mill, where the clatter of machinery is so great that one has to shout to make one's voice heard.

CHAPTER X

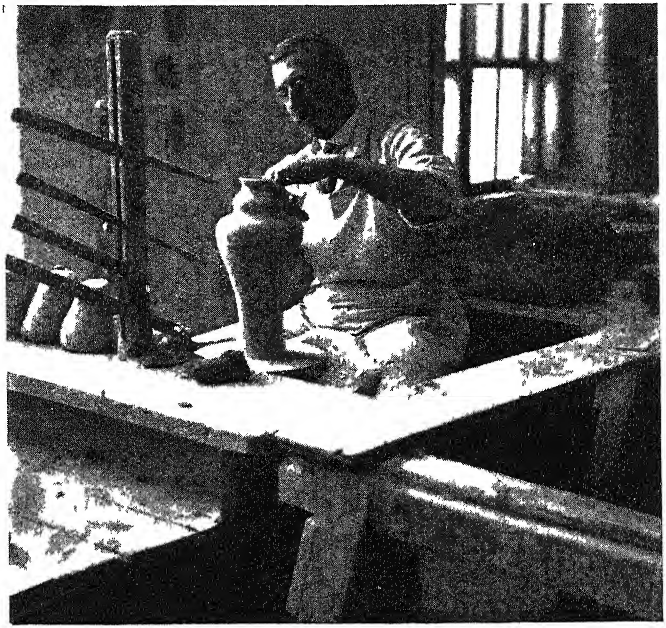
A TOUR ROUND THE POTTERIES

St George's Day, 1913, was a red-letter day in the history of the Potteries, for then King George honoured this district in North Staffordshire with a personal inspection of the works and the various processes of the potter's art. Could we have been in the Potteries on that day we might have seen the royal motor-car running up and down the streets—many of them back streets, too—and the King and Queen being cheered by the loyal potters and their families. At Burslem a very unique welcome was given to the royal party, for two dozen boys and girls each held an enormous plate before them on which were the words "Your Majesty's Loyal Potters"

In one factory the King saw the materials from which the potter makes his paste—potter's earth from Devon and Dorset, kaolin or china-clay from Cornwall, and flints from the French coast. In another works they watched the potter moulding the clay upon his wheel; in another, the firing, glazing, painting and gilding of the ware until the rough paste had been fashioned into beautiful jugs and plates of costly design. A dinner-service costing £3000 was inspected, and, by way of contrast, another service costing a few shillings. In one room a girl was lining a coffee cup, which bore upon it the royal monogram "G. R.," with a black paint, but she explained to the King that it would come out gold when

it was fired. Naturally the King was highly interested in seeing made some of the ware destined for the royal palace.

The name of Josiah Wedgwood is honoured highly



THROWING. DOULTON & CO. LTD.

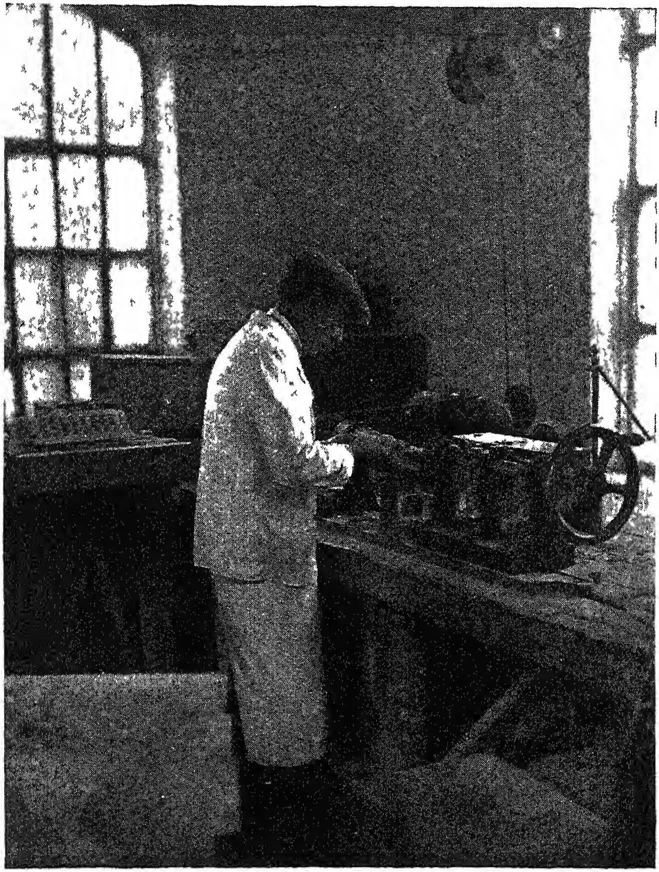
in North Staffordshire, for it is mainly to him that the potters owe the origin of their great and important trade.

At Stoke, the chief of the five towns forming the Potteries, a statue of Wedgwood has been erected, but his name and fame are more widely known by the special ware called after him. Probably many of you have in

your homes ‘Wedgwood’ butter-dishes, ‘Wedgwood’ jugs and jars, and so on. Josiah spared no expense in the employment of famous artists to adorn his ware, and the works of Messrs Wedgwood at Hanley are known far and wide.

The predominating colours in Wedgwood ware are blue and white, and when the King visited the Wedgwood factory the buildings had been draped in blue and white. The colour scheme was further illustrated by the hundreds of workpeople, for the men were dressed in white with blue aprons, and the girls in blue with white overalls.

Many of the blue jasper vases admired by the King were perfectly moulded and were of delicate beauty. But the royal party saw one side only of the work; in the processes of ‘dipping,’ ware cleaning, colour dusting, ground laying, majolica painting, and litho-transfer dusting, much lead is used, and many of the workers have suffered in some form or other from that dreadful malady, lead-poisoning. Of late years this disease has been less common because of the strict regulations enforced by law upon the potters. A few years ago ‘raw’ lead was used, but it is now fritted, and the danger of lead-poisoning is lessened. The beautiful glaze which appears on the ware is made by dipping the articles in a glazing mixture. The chief substance composing the mixture is lead, and when the ware is dipped men plunge the articles into the mixture with their hands, thus covering hands and wrists with the fluid. All the dippers, however, do not feel harmful effects; the liability to contract lead-poisoning seems to depend almost entirely on the general health of the person, and the carelessness which he shows when he eats his meals with unwashed hands, and when he ‘dips’



TURNING. DOULTON & CO LTD.

with cut hands or broken skin. The man who was 'dipping' was asked by the King whether he felt any ill-effects and how long he had been at it. "I've been at it thirty-five years, your Majesty," was the reply, "and I'm as strong as ever. There is nothing to complain of."

Pottery authorities say that the use of lead is quite necessary; they would gladly do without it if an efficient substitute could be found, but ware dipped in a leadless glaze does not appeal to the public, and is made at a loss. They do all that they can to lessen the risk of lead-poisoning; the women are compelled to cover their hair with caps and to wear long overalls while at work; under no circumstances may food be eaten in the 'dipping' room or in any other room where lead is used; and the workers in lead are strictly forbidden to leave the pot tanks without washing their hands. Certainly these precautions have reduced the number of fatal, or very severe, cases of lead-poisoning.

A few years ago the pottery towns of Burslem, Hanley, Longton, Fenton, Tunstall, and Stoke were linked up into one large borough—the thirteenth largest borough in England—known as the borough of Stoke-upon-Trent. This district is about nine miles long and from three to four miles broad, and it contains a population of about a quarter of a million inhabitants. All the separate towns are joined by a tramway system, and in all there are about thirty-two miles of tram-lines.

CHAPTER XI

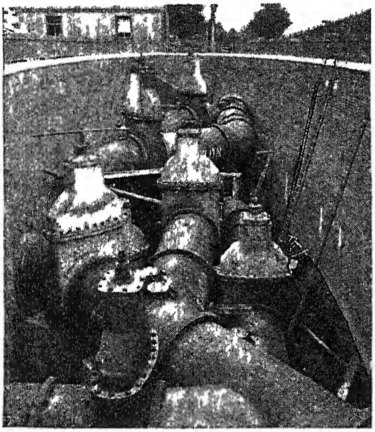
HOW LARGE TOWNS GET THEIR WATER-SUPPLY

WE have seen that in many of the hives of industry the workers and their dwellings are packed very closely together. That part of a large industrial town which contains the homes of the workmen who flock in thousands into the enormous mills and factories, is composed mainly of row after row of small houses or flats. Probably there are more people living in the houses of one street only than there are in a fair-sized village.

You can well understand that an enormous amount of water is used in our large towns, and the problem in the past has been to find the most suitable means to convey drinking-water to the inhabitants of congested districts. Those of you who live in villages have little trouble over your water-supply. In the middle of many villages there is the village pump, and this, with a dozen or so of privately-owned pumps and wells, are quite sufficient for your needs.

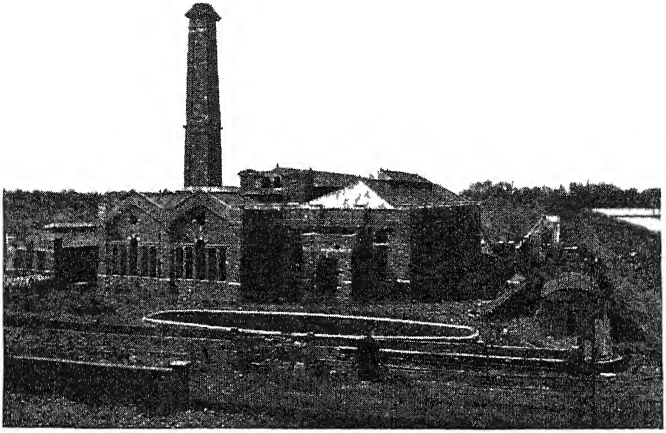
But a few pumps would be of very little use in the industrial quarters of our cities. Long, long ago, when these enormous cities were small villages or hamlets, probably two or three wells were sufficient, but other sources of water-supply have had to be discovered. In many cases the water has to be carried in enormous pipes dozens of miles before it reaches the city. Thus the

people of Manchester drink water which comes from Lake Thirlmere in the Lake District, nearly one hundred miles away. It was a very expensive undertaking for Manchester to tap the water of Thirlmere. First, an enormous dam had to be built at one end of the lake, so that the water did not escape as it had hitherto done; then a huge filtering-well had to be made over sixty feet in depth; and finally, a tunnel, stretching right away to Manchester had to be excavated.

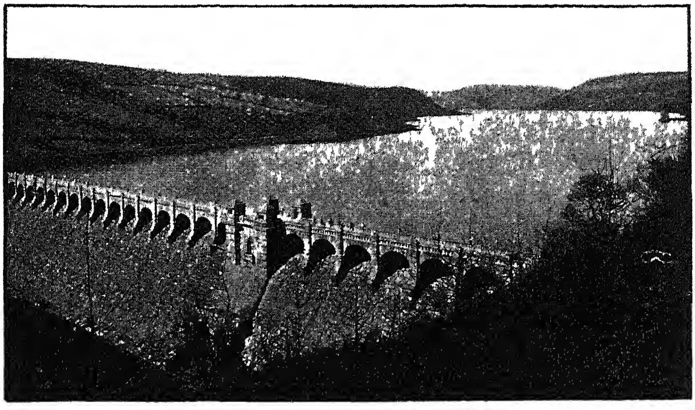


The Junction of Main 48 inch Pipes at Walton-on-Thames. Valves control the Supply of Water to different Districts

Nearly all large towns have to depend for their drinking-supply upon the springs, rivers, and lakes on the hill-sides or valleys some miles away. Liverpool depends for its water-supply upon Lake Vyrnwy in Wales. Much of the water used by the inhabitants of North London originally fell as rain on the Chiltern Hills and East Anglian heights, and it is brought to the huge reservoirs by the River Lea and the New River. The latter is really a canal cut by Sir Hugh Myddleton about 300 years ago. Sir Hugh spent his entire fortune over the construction of the canal, and he hoped that he would recover his money by the New River shares which he offered for sale, but only a very few people would buy



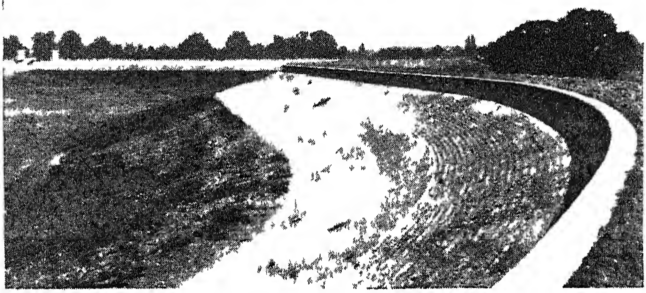
WATER-WORKS AT WALTON-ON-THAMES



LAKE VYRNWY AS IT NOW IS

them, and at first the scheme was a failure. In time, however, the water brought by the canal was used in the northern suburbs, and the shares were eagerly taken up, and rapidly increased in price. Some descendants of those people who held the original shares which have been handed down in their families during the last three centuries, are very wealthy owing to the foresight of their ancestors.

One of the largest reservoirs in the country is that at

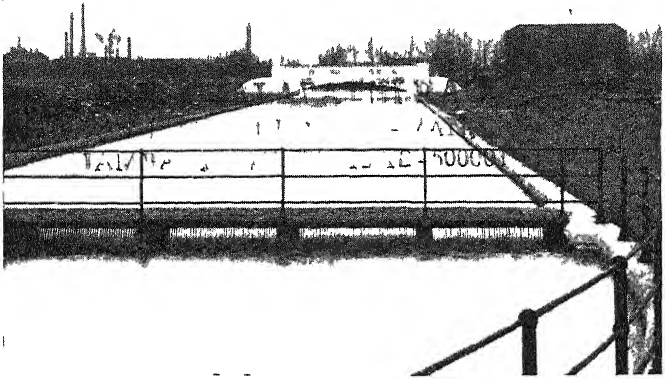


THE CONSTRUCTION OF A BANK OF A RESERVOIR

Chingford in Essex. This was opened by King George in 1913, and it cost £500,000 to construct. The area of the reservoir is 460 acres—that is, larger than Hyde Park—and in some places it is forty feet deep. It was feared that a hurricane might cause large waves to form, which would dash against the parapet and damage it, so a huge breakwater cuts the reservoir in two parts.

It would take you an hour to walk all round the embankment of this inland sea, and it is nearly two miles long. The walls enclosing it are about two hundred feet wide.

But, wonderful as the construction of the reservoir has been, there is something even more marvellous. To fill it the water has to be obtained from a channel, about fifty-five feet wide, of the adjacent River Lea. When the reservoir was about to be constructed, the great problem to be solved was how to lift the water a distance of twenty-six feet from the Lea to the reservoir. A very

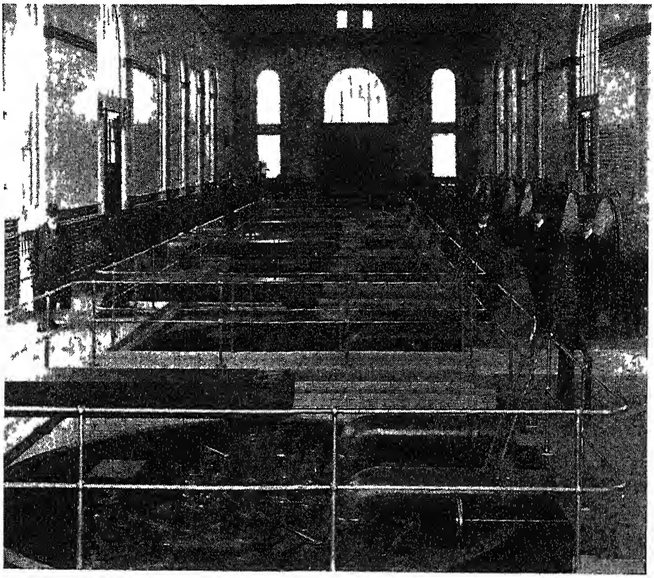


INTAKE CHANNEL FROM THE RIVER LEA

clever engineer, Mr Humphreys, had just invented a water-pump on a new principle, and he undertook, with the Metropolitan Water Board, to make pumps of sufficient power to transfer the necessary 180,000,000 gallons of water every twenty-four hours. The Board hesitated to believe that such a feat was possible, but they agreed to allow the inventor to undertake the contract on the condition that he should forfeit £20,000 if his pumps should prove a failure.

Nothing daunted, the young engineer set to work,

and took the risk of losing that great sum of money His efforts were entirely successful The five great pumps which he laid down can lift 250,000,000 gallons of water into the reservoir in a day and at a less cost than the Board estimated for half that quantity. Mr Humphreys

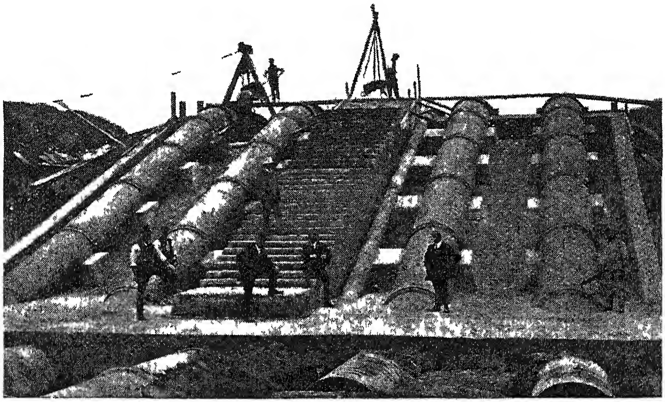


THE NEW PUMPING MACHINERY AT CHINGFORD

is to-day famous among engineers, and he has since been asked to supply the Egyptian Government with pumps for drainage purposes even more powerful than those at Chingford.

Those of you who have a little knowledge of engineering can easily follow the action of the pumps. You know that an ordinary engine has a fly-wheel, crank-shaft,

cross-head, gearing or staffing-boxes, connecting-rod, and piston. But in the Humphreys pump there is none of these. All the parts found in the ordinary engine are absent, and yet the pump may be described as a gas-engine and pump combined The principle on which it works is exactly the same as that of the ordinary motor-car engine. You know that the engine must 'spark'



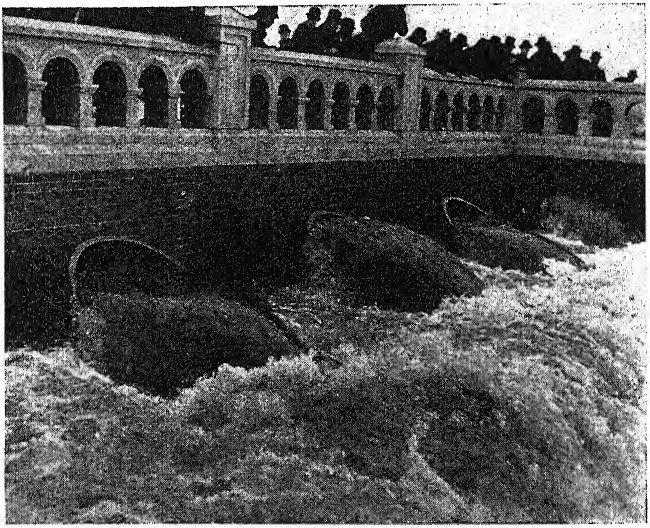
THE 48 INCH PIPES BEFORE BEING COVERED UP
(These show the rise of 26 feet up which the water must be pumped)

before the car starts, and the 'spark' is really an explosion caused by a mixture of petrol vapour and air. This explosion moves forward the piston and the wheels of the car begin to revolve.

In the Humphreys pump, gas, obtained by the burning of anthracite coal, takes the place of vapour in the motor-car engine, *and the piston-rod is water.* This is what makes the pump so unique in engineering construction. An electrical sparking plug explodes the mixture of gas

and air, and this explosion drives forward the water in a giant tube—the diameter of which is large enough to allow of a man standing upright—up a tower open at the top, from which it flows into the reservoir.

If you make a rough sketch of a U-shaped tube you

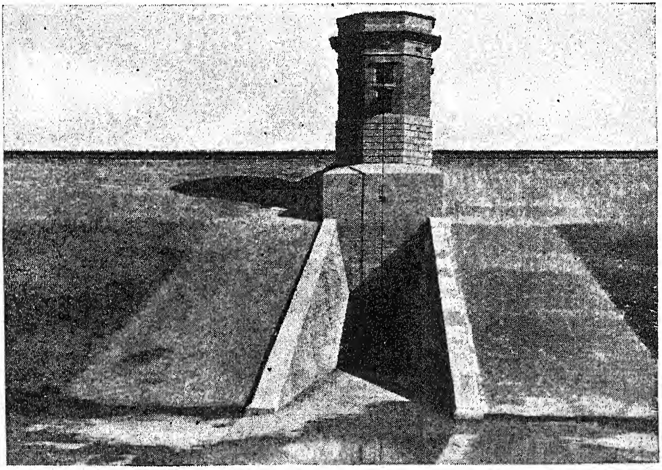


THE NEW PUMPS IN OPERATION AT CHINGFORD

will understand better how the pumps work. At one end water from the River Lea flows into the pump, and at this end there is the explosion chamber. A column of water moves backward and forward in the tube between the explosion chamber and the tower at the opposite end.

If all the pumps were kept working together the Lea would soon be drained dry. It is intended to use this enormous lifting capacity only when heavy rains make

the river rise. At each explosion of a single pump, twelve tons of water are taken out of the river and delivered into the reservoir. And the pumps are under such perfect control that all of them may be at rest one moment, and yet all working at full speed a few moments later.



WATER-TOWER AT CHINGFORD CONTROLLING THE OUTLET FROM RESERVOIR

For the present the water will be stored in the reservoir, as we were told, " for a considerable period during which purification processes will take place by the agency of natural forces, and after this the water will flow through regulating towers into a tunnel and then along a channel nearly two miles long to the existing distributing basin adjoining the Chingford Mill pumping station."

Some idea of the immense quantity of water required

by the people in London and its suburbs may be obtained by imagining an enormous tank, as large as the whole of Trafalgar Square and as high as Nelson's Column, filled with water. This tank would have to be filled three times a day to provide enough water for the eight or nine millions of people in Greater London. Five enormous reservoirs, of which the Chingford reservoir is the most important, form a chain extending from Walthamstow to Enfield Loch, and these provide the densely-populated parts of the East and North-east quarters of the Metropolis with water.

[The illustrations in this chapter, excepting the view of Lake Vyrnwy, have been kindly supplied by the Metropolitan Water Board.]

CHAPTER XII

IN A SLATE QUARRY

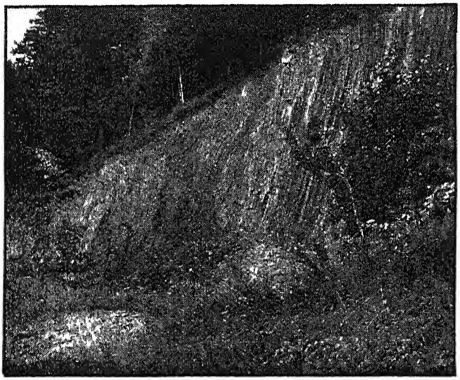
To-day we will take a trip to North Wales and watch the men at work in the great Penrhyn slate quarry. It is well that we should know something of slate, and how it is obtained from the rocks where it has been buried for thousands of years, because slate is used in one form or another in nearly every English town and village, and also because the British slate industry is a highly important one.

The Penrhyn quarry, near Bethesda, is one of the largest slate quarries in the world, and at one time it employed over three thousand men. Other important Welsh quarries are those at Festiniog and Llanberis.

In very remote ages slate was deposited on the ocean floor as fine mud formed by the waste of rocks in the vicinity; thus slate is known as a *sedimentary rock*. This mud, or shale, became hardened by intense pressure, and film after film of sediment was placed one upon another, and became compressed into a compact mass. The films, or *laminæ* as they are called, acquired a tendency to separate one from another, and one of the characteristics of slate is that it can be split into thin plates. Strange to say, the laminæ do not, as a rule, run parallel with the bedding or strata; they are often at right angles to it. This shows that the muddy sediment was subject not only to pressure from above, but

it has undergone intense side, or lateral, pressure. When rocks are split into layers or flakes more or less at right angles to the original strata, they are said to have *cleavage*.

The general appearance of a slate quarry is that of an enormous amphitheatre, somewhat similar to the Coliseum of Ancient Rome. Some quarries are a thousand feet deep, and consist of a series of steps or terraces, about fifty feet high and a few yards wide. Small trams run along each terrace, and convey the slate to the hydraulic lifts, where it is raised to the surface. When the rock is embedded very deeply in the earth, it has to be quarried in underground chambers. Sometimes shafts, similar to those in use at a coal mine, have to be sunk, but the cost of mining slate is very heavy and almost prohibitive. In such a mine there are installed a system of tramways, waggons, tubs, etc., as are found down in a coal mine.



A Slate Formation

The galleries in an ordinary quarry are worked in sections of ten yards, and each section has employed on it a crew of five or six men. The hard rock is bored by drills, which are turned by hand and driven by hammers. If the bore be small, one man can work it by holding

the drill in his left hand and hammering with his right. But for a large bore one man guides the drill with both hands, and two or three men hammer it into the slate. Before the bore is made the men search for a natural joint in the rock, as this helps to prevent the rock from splitting; the great thing to be avoided is the splintering of the rock when it is blasted, because small pieces of slate are of little value.

The blasting of the rock generally takes place at twenty-five minutes past each hour. A special blasting-powder is used which throws out great masses of rock without splintering it; most explosions would shatter the rock to fragments. After the rock has been blasted all good slate is sorted out from the heap, and run off in trucks to the slate huts to be split and dressed. A splitter and a dresser usually work in partnership with each other; the former placing a block of slate on end between his knees, and splitting it into thin plates of the required thickness with a chisel and a mallet; while the latter places the split plates on a stand, and with a sharp knife cuts them into the necessary sizes.

The names used to denote the various sizes of slates are words relating to the various orders of Society. Thus we have 'princesses,' 'duchesses,' 'countesses,' 'ladies,' and so on, according to the size of the slate. A 'princess' measures twenty-four inches by fourteen inches; a 'duchess,' twenty-four by twelve inches; and the others in proportion.

Slates of superior quality, such as those used for the beds of billiard-tables, or for swing-slates in schoolrooms, have to be highly polished, and the great labour spent upon them makes them very expensive. Slates which are intended for the roofs of houses are very cheap, as little labour has to be expended upon them after they are split.

CHAPTER XIII

A TRIP UP A CANAL[1]

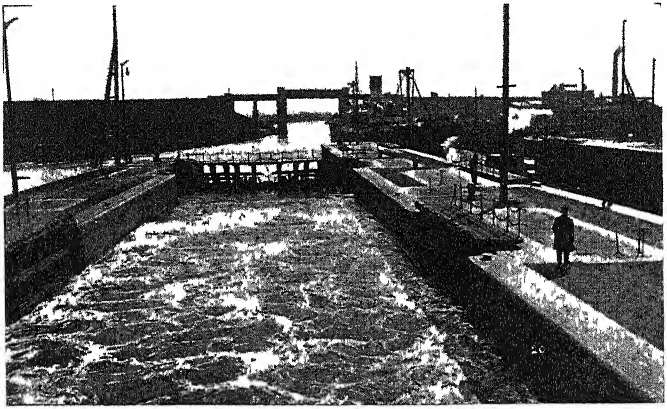
A CENTURY ago merchandise could be sent only by the sea, river, canal, or road, as it was not until 1830 that Stephenson's *Rocket*, the first railway locomotive, ran its trial trip on the Liverpool and Manchester Railway. Two centuries ago there were no canals in this country, and the chief means of carrying both raw material and manufactured goods was by river.

But navigable rivers, excellent though they are as commercial highways, are not always found where they are wanted. True, most of our large towns stand on the banks of rivers, but there are some important centres of industry, such as Birmingham, through which no large rivers run. In such places as these canals have been constructed so that the towns may be connected by water, either with the sea or some navigable river.

The first canal made in this country was the Bridgewater Canal, which was constructed by James Brindley, an English engineer, between 1758 and 1761. The canal was built to the orders of the Duke of Bridgewater, who owned an estate at Worsley, a place about seven miles from Manchester. On the Worsley estate there were very valuable coal mines, and the Duke, wishing to establish a communication between his mines and

[1] The illustrations to this chapter are from photographs supplied by the Manchester Ship Canal Company.

Manchester, employed Brindley to undertake the work of constructing a waterway of sufficient width to allow of barges, laden with coal, being drawn along it. The idea was ridiculed by many people, but Brindley plodded on, and by means of bridging valleys and rivers by aqueducts his scheme was entirely successful, and Worsly was effectually linked up by water with the Mersey. Other

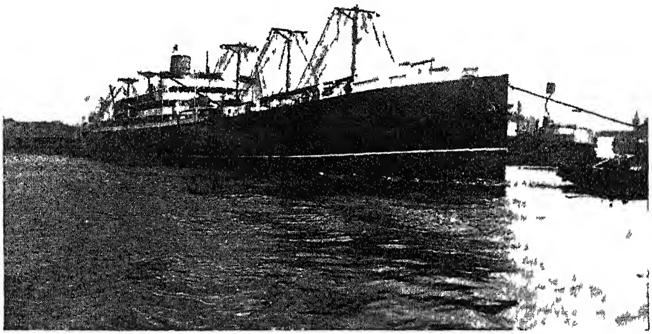


OUTWARD-BOUND STEAMER LEAVING THE LARGE LOCK AT IRLAM

canals soon followed, and in a few years the same engineer had constructed the Grand Trunk Canal, joining the Trent and Mersey, and another canal uniting that with the Severn.

Nowadays there are few parts of England far removed from a canal, and the united length of all the canals would exceed 4000 miles. To see how the various towns are connected by water, you should trace the course of the rivers and canals on a special map which shows them. You will find that it is possible to cross England

from the North Sea to the Irish Sea by river and canal, and people who are fond of spending their holidays on water sometimes make a circular trip from the Thames to the Severn, and then along various canals through the Midlands back to the Thames again. Just trace this journey on the map, and note what towns are passed through.

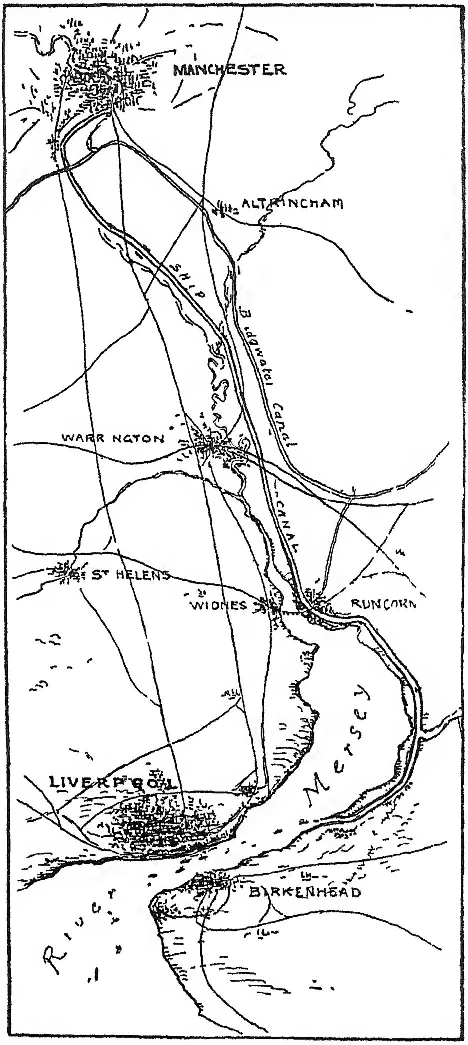


S.S. "Argyleshire" turning in the Basin at Manchester

You must not expect to find a trip on a canal as interesting as one by river. There are no pretty backwaters in which one may lie lazily at anchor; one cannot land on picturesque islets for a picnic; in place of the fretted banks of a river we find bare, straight sides of the same height all along the course, and bordered by a wide tow-path. There is a drab monotony about a canal journey.

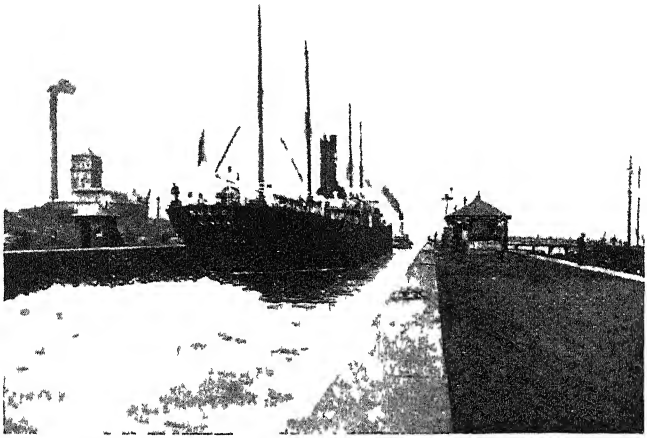
The canal which we have chosen for our voyage is the

Manchester Ship Canal, partly because it is one of the most modern canals, and also, because we may pass some ocean-going steamers. This famous waterway is $35\frac{1}{2}$ miles long, and it connects Manchester with the Mersey estuary. Before this canal was made the cotton-ships were unloaded at Liverpool, and the cotton bales had to be reloaded and transported to the cotton-towns by road or rail. For over a hundred years the idea of constructing a wide waterway between Liverpool and Manchester had been actively discussed by the prominent



MANCHESTER SHIP CANAL

citizens of both places, but it was not until 1882 that practical steps began to be taken for carrying out the scheme. The actual work was begun in 1887, and it extended over a period of six years. Those of you who have seen cinematograph pictures showing the construction of the Panama Canal will have some idea



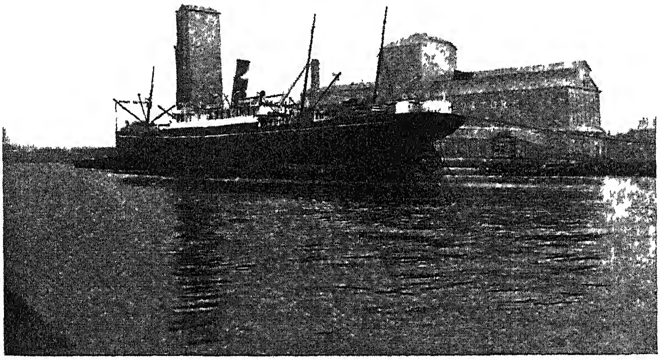
THE ENTRANCE OF THE CANAL FROM THE RIVER MERSEY

of the difficulties the engineers had to encounter in cutting a channel over thirty miles in length.

We enter the canal at Eastham, a town standing about five miles from Liverpool, on the left bank of the Mersey estuary. The water, of course, has a brackish flavour, as the tide runs up the canal for a distance of twenty miles. Innumerable docks line the canal, and big steamers and numerous smaller boats and barges pass each other. The canal is of sufficient width to

allow of two of the largest ocean-going steamers to pass.

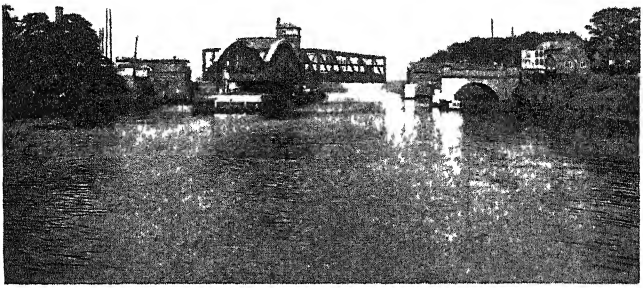
To obtain some idea of the width of the canal you must imagine two full-sized cricket pitches placed end to end, and a length of half another cricket pitch added. This would make a total distance of 165 feet, and the average



GRAIN ELEVATOR AT MANCHESTER
(Capacity, 40,000 tons, or one and a half million bushels)

width of the canal is seven feet more than this. The banks slope inward to the bed of the water, so that the width of the bottom does not greatly exceed 100 feet. The depth of the water is about thirty feet The scenery along the banks is most unpicturesque, unless we regard that which includes dingy wharfs, giant cranes, dirty docks, and dozens of factories, as picturesque. Our progress is somewhat retarded by a number of

locks, through which we have to pass. As the difference of sea-level between the end of the canal at Salford and the entrance to it at Eastham is sixty feet, it was found necessary to raise the level by means of locks. Probably most of you have seen a lock, or have gone through one in a boat, and you are quite familiar with its action



VIEW OF SWING-BRIDGE WHICH CARRIES THE BRIDGEWATER CANAL OVER THE SHIP CANAL

At intervals we pass under bridges which are used either as roads or railways. In all there are six high-level bridges and seven swing-bridges.

Quite one of the most remarkable occurrences on our journey is met with at Barton. Here the Bridgewater Canal has to cross the Ship Canal, and when the latter was being planned the method by which one waterway was to cross another one presented an intricate problem. Finally, it was decided to build a solid pier in the centre

of the Ship Canal, on which to mount a swing-bridge, or caisson. When a ship passes through the lower canal at this point, the water on either side of the Bridgewater Canal is shut off, or locked, by means of sluices, and the caisson swung so that it points up and down the waterway. As soon as the ship has passed, the caisson is

VIEW IN THE MANCHESTER DOCKS

swung back into its natural position, and again fulfils its function as an aqueduct for the upper canal.

Vessels showing the flags of nearly every maritime country in the world pass by or are moored alongside the quays at Warrington, Eastham, Salford, and other places. Many of the ships have come from the cotton-producing States, bordering the Gulf of Mexico ; others arrive with wool from Australia and South Africa ; cattle-boats from New Zealand are seen ; tea-ships from Ceylon ;

timber-boats from Canada; vessels laden with corn grown in Manitoba, Ontario, and the eastern Canadian States; ships, steamers, barges, and boats of all sizes and descriptions ply up and down this thirty-five miles of waterway. All have to pay a toll, and the annual revenue derived from all classes of vessels using the canal amounts to many thousands of pounds.

CHAPTER XIV

A RAMBLE ROUND A BOOT-TOWN

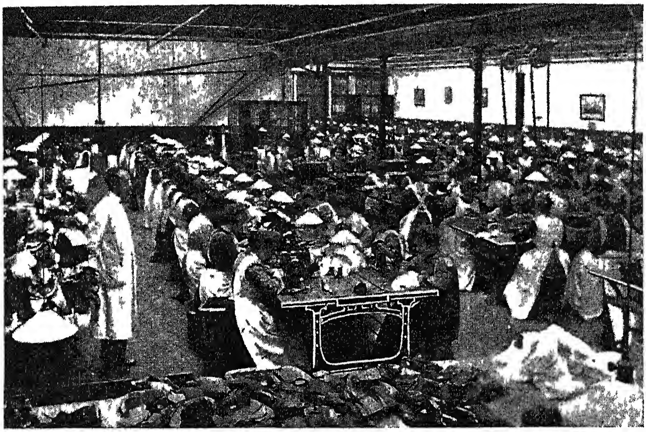
COME with me for a ramble in a Midland town where the great majority of the workers are engaged in one branch or other of the boot trade. Unlike many centres of industry this town has one manufacture only; it is a town of one trade, where thousands of people supply the demand of thousands of boot-shops throughout the world. The capital of 'boot-land' is Northampton, but the factory which we are about to inspect here is quite similar to the boot factories at Stafford and Leicester, the other great centres of this important industry.

Nowadays almost every process in the making of boots is done by machinery, but years ago boots and shoes were made by hand, and shoemaking was then a village industry. Every village had one or more cobblers' shops, probably with the words "There's Nothing like Leather" imprinted on a card, and hung up in a conspicuous place. In those days a cobbler did well if he made two pairs of boots in a week; many modern boot factories average from twelve to twenty thousand pairs in that time.

Perhaps you may expect to see tanneries all around Northampton, for you rightly associate leather with tanning, but our great tan-yards are at Bermondsey and Bristol. It has been found most convenient to have

tanneries near the docks where the hides, most of which come from abroad, are landed. Nearly every country in the world is laid under tribute to the tanner, whether it be Brazil for its hides from wild horses, New Zealand for oxhide, Switzerland for goat-skin, or the far North for the skin of the reindeer.

If one walked through the streets of Northampton in



THE CLOSING-ROOM OF MESSRS MANFIELD & SONS' WORKS

the daytime the town, when compared with most industrial towns, would appear remarkably quiet. The factories, too, are by no means 'skyscrapers,' and many of them are built almost entirely on the ground floor. We conclude that, when the buildings were first laid out, there was abundance of room to extend them without the necessity of building upper storeys, and a factory of one floor only effects a great saving of labour over one with scores of steps to be climbed, and where lifts are needed

to convey the raw and manufactured materials to and from the upper storeys.

Neither do many of the Northampton factories have that dingy and smoke-begrimed appearance which is associated with a cotton-mill, a weaving-yard, or an iron-works. Some of the principal buildings actually have lawns and ornamental shrubs in front of them, and, unless you were told, you would never think that hundreds of workmen were busily engaged with all kinds of machinery within the walls of the big building before you.

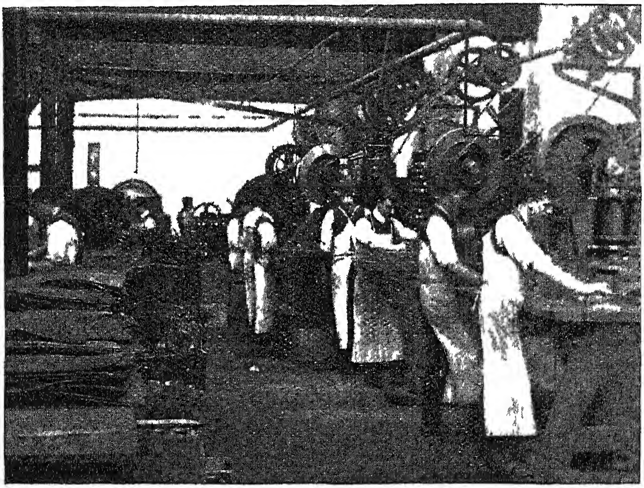
When we enter the factory the first place we are shown is a store-room for leather. Here we see leather of all kinds of texture and colour. Soft and very pliable leather for the uppers of fancy shoes; suède for ladies' slippers; 'patent' leather for dancing 'pumps'; hard sole leather; stout upper leather for workmen's boots; leather which will be made up into boots and shoes costing several pounds, and leather for boots costing but a few shillings. Thousands of pounds worth of leather rests neatly packed in this huge store, but we are told that it will supply the needs only of about five or six months.

We now enter the room where scores of men are cutting uppers out of the tanned skins. This is called the *clicking-room*, and long practice makes the workmen very quick at their work. Were we to try to cut out an upper we should make a sorry muddle of it, even with the sharp knife which is used.

The next room contains three or four hundred girls, and there is a loud hum of machines all around us. There are machines of all sorts; machines for punching eyelet holes, others for making the ornamental patterns seen

on the uppers of boots; still more for working the button-holes; and even machines for sewing on buttons. Clever inventors have produced most intricate machines for the boot trade, and the saving of labour has been enormous.

In another room we see a wonderful machine which stamps out a sole. What a contrast to the methods



CUTTING SOLES IN MESSRS MANFIELD & SONS' WORKS

employed by the old village cobbler, who laboriously cut out the stout leather from a paper pattern and pared it down on his lapstone! And then, when he had fashioned the uppers he required much skill and energy to last the boot, and hand-stitch the welt, upper and inner sole together. All these processes are carried out by machinery; there is a machine to pull the upper on to the last, another to prepare the welt, and two or three

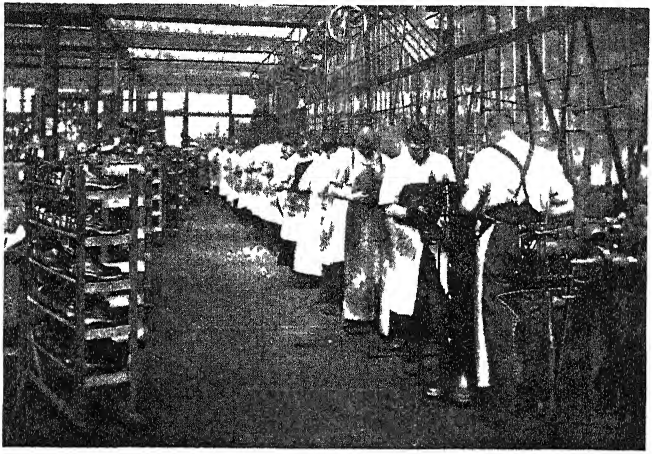
more to make the groove in the sole and sew on the sole. Sometimes, however, for very special work, hand-sewers are employed. No dressmaker ever stitched together two pieces of cloth with more precision than the boot machinist performs his work at the sewing-machine.

We are told that the modern boot factory is indebted to America for many inventions of sewing-machines,

A GROUP OF HAND-SEWERS IN MESSRS MANFIELD & SONS' WORKS

and that the Americans were the pioneers in this branch of industry. America will always be associated with the invention of the standard-screw machine, which inserts screw-threaded brass wire through outside, upper edge, and inside. For many years standard-screw boots were in great demand. After the American Civil War other inventions of sewing-machines followed, as there was an enormous demand at that time for soldiers' boots.

We all know what an attractive appearance new boots have. Even the soles are smooth and coated with a glossy black, and we are almost sorry that we have to put them in the mud, when all the 'finish' will be worn off in less than five minutes. Much care is taken over the scouring and blackening and trimming. It is of



FINISHING-ROOM OF MESSRS MANFIELD & SONS' WORKS

little practical use, especially on the under parts of the sole, but the manufacturer knows that the public will want to buy boots which are pleasing to the eye, and he has to spend much time over the various finishing processes.

The last room we visit is the stock-room, which contains thousands of pairs of boots waiting to be sent to all parts of the world, for Northampton does a great export trade in boots and shoes. When we think of the millions of

people there are in the United Kingdom alone, we get a faint idea of the enormous demand which the boot factories have to supply, and, as our boot factories are world-famed, we see how highly important is the industry which Northampton and its sister towns carry on.

CHAPTER XV

IN A GLASS-HOUSE[1]

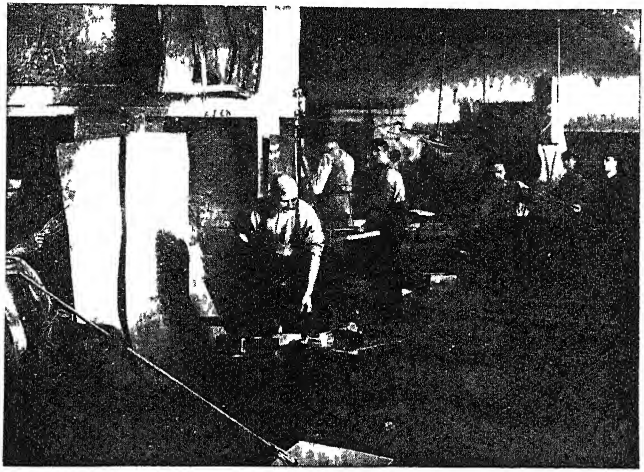
THE Roman historian, Pliny, has related an interesting and romantic story of the origin of glass, and, if it be correct, the discovery of glass may be said to be due to lucky chance.

According to Pliny a number of shipwrecked mariners were cast ashore on the coast of Syria. Their cargo consisted of an alkali known as nitre. The sailors are said to have encamped near the shore, and having no stones on which to rest their cooking utensils, they used pieces of the nitre washed up from the ship. The fire quickly melted the lumps of nitre, and the molten alkali flowed amongst the sand Soon a clear, transparent substance was formed which greatly astonished the sailors. After returning to their homes they repeated the experiment of melting nitre and mixing it with sand, and in this way obtained the first but crude idea of making glass.

In modern times glass is made under very different conditions from those employed by those Eastern sailors, but very similar materials are used, and the original method of fusing some substance containing silica—such as powdered flint or fine sand—with an alkali, is carried out in most glass-works.

[1] The illustrations show processes in the making of a wine-glass at the works of Messrs Thomas Webb & Sons, Ltd , Stourbridge.

The nature of the glass will, of course, depend upon the quality and proportion of the various alkalis, alkaline earths, salts, metallic oxides, flints, etc., of which it is formed. You know that there are many different varieties of glass, such as window-glass, plate-glass, bottle-glass, and so on. In a glass-works five



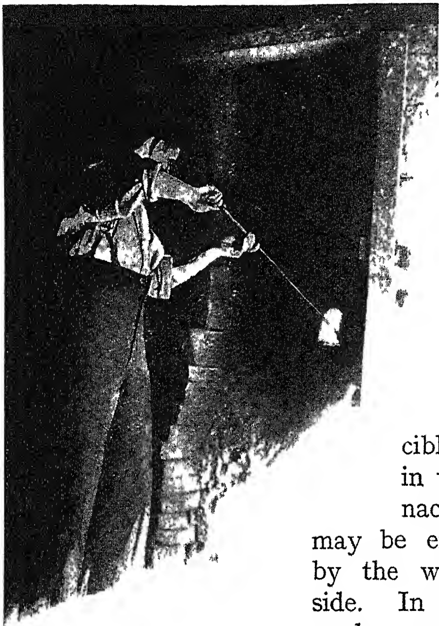
INTERIOR VIEW OF THE DENNIS GLASS-HOUSE, STOURBRIDGE

kinds are usually recognized. These are. (i) Bottle, or coarse green glass; (ii) Sheet window-glass; (iii) Crown-glass or best window-glass; (iv) Plate-glass; (v) Flint-glass.

Glass-houses, or works where glass is made, are usually cone-shaped and built of brick. Running right across the interior of the building is a large vault, which is of sufficient height to allow the workmen to wheel out

waste material from beneath the furnace, which is placed over the vault.

The materials which have to be fused are placed in a melting-pot made of fire-clay. Fire-clay will withstand great heat, and most crucibles used in glass-houses are made of Stourbridge fire-clay. A number of crucibles are placed in one furnace at equal distances from each other round the circumference, and opposite each crucible there is an opening in the wall of the furnace so that the crucible may be emptied and refilled by the workman from outside. In some modern glass-works crucibles are not used; a furnace known as the *tank* furnace has been invented, where the fusion of the various ingredients can be worked from the furnace direct.



THE HOLLOW BLOWPIPE IS INSERTED INTO THE MOUTH OF THE POT AND COLLECTS A QUANTITY OF THE 'METAL'

Each crucible is heated for about sixteen hours, but the time varies according to the materials used. When the fusion is complete the molten glass is annealed in an

annealing furnace. Here it cools slowly, and becomes more tenacious. The annealing process requires very great care, for if unsatisfactorily carried out, the articles will be too brittle for use. For some qualities of glass the articles are gradually cooled in oil, and this increases their tenacity.

ROLLING THE SOFT 'METAL' ON A POLISHED IRON TABLE TO GIVE IT A SMOOTH, EVEN SURFACE

You would be interested in watching a glass-blower at work. When the materials are properly fused he takes a quantity of the molten mixture from the crucible on the end of an iron tube about five feet long. It is first rolled into a cylindrical form on an iron table, and then the workman blows it until it assumes the shape of a hollow globe. It is reheated again and again, and blown until the globe becomes of the required thickness.

To make a hole in the extremity of the cylinder he softens the glass in the furnace, and afterward stops up the tube with his thumb. The hot air in the tube quickly expands, and causes the cylinder to burst open at the end where it had been heated. The other end is

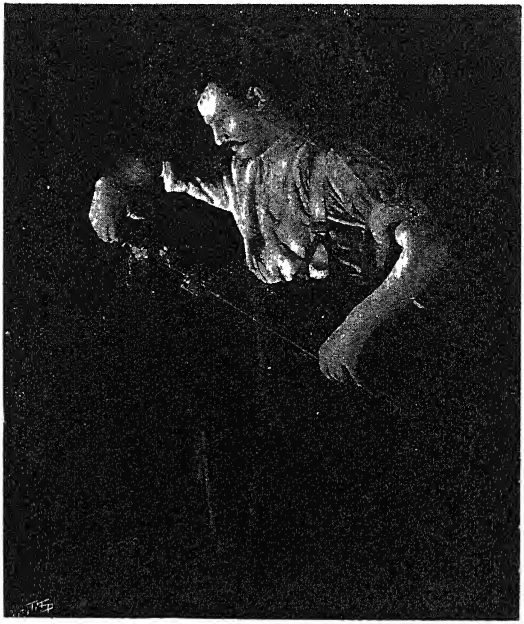
cooled and detached from the tube by winding round it a thread of red-hot glass. The cylinder is then cut open with a diamond, and afterward placed in the flattening furnace, where it is heated and opened out into a flat sheet.

In making globes, ornaments, wine-glasses, and table

Casting on the Stem of a Wine-glass

utensils very fine sand is needed, and the alkali is usually potash instead of soda. This kind of glass is called flint-glass, or crystal, because it is very bright and clear. To fuse the materials the furnace has to be kept at an extremely high temperature, and when the mixture is sufficiently clear the temperature is gradually lowered. The liquid glass is lifted out of the crucible by an iron tube, and poured out on to an iron table, where it is

rolled smooth. If a globe is required the glass-blower reheats the glass, and takes a little of the molten mixture on the end of his blowpipe. This he blows out into a

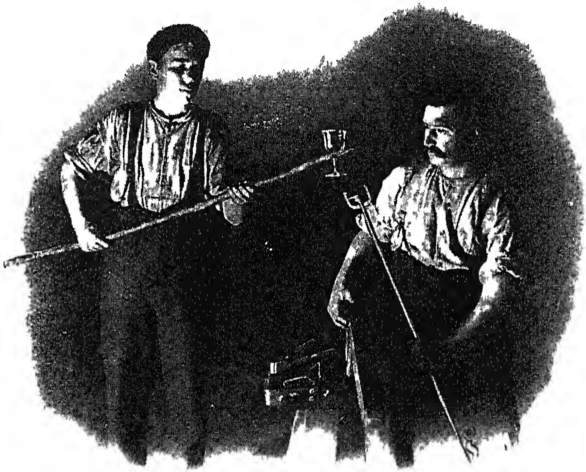


Cutting the top of a Wine-glass with Shears

cylinder, much after the manner in which a boy blows a soap-bubble in the bowl of a clay pipe. To obtain the required thinness the blower has sometimes to re-heat the glass three or four times. He then works the globe, cup, or wine-glass into shape with iron tools, and affixes the necessary stems, etc., by separate pieces of soft glass.

As a rule, those articles, such as glass bottles, jars, jugs, and so on, which have to be all of the same shape, size, and thickness are blown in moulds.

The numerous colours and tints in glass are obtained by mixing with it the metallic oxides of iron, copper, or other metals. If the glass is entirely coloured the



RELEASING THE GLASS FROM THE HOLDER

colouring matter is melted in the furnace along with the other ingredients; if it is tinted, or partly coloured, a quantity of molten white glass is removed from one crucible and dipped into another containing the coloured glass.

Great Britain has of late years taken a prominent position in the glass-making industry, and the chief English centres are at Stourbridge, St Helens in Lanca-

shire, and some of the Tyne ports. Much coal is used in the manufacture of glass, and most of our glass-works are near coal-fields.

In the early days of the glass-making industry Venice was greatly renowned for its mosaic glass, frosted glass, and glass ornaments, such as cups and chalices for use in the services of the Church. During the last century the Venetian trade has gradually declined, and now the leading glass-producing countries are Germany, Belgium, France, and Britain.

CHAPTER XVI

IN THE PORTLAND QUARRIES

In Dorsetshire, not far from Weymouth, there is a small peninsula about three miles long and two wide, which is practically a solid mass of stone. This peninsula is known as the Isle of Portland. Just why it should be called an island is not quite clear, because a long low ridge of shingle, called the Chesil Bank, connects it with the mainland. Centuries ago it is said that this isthmus did not exist, and then, of course, Portland was an island, so this is probably the reason why the present peninsula is wrongly named.

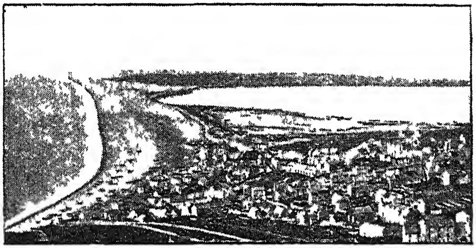
Standing on a hill-top, in one corner of the peninsula, is a large convict prison, and many of the convicts have to work in the stone quarries surrounding the prison. Perhaps you have seen pictures on the cinematograph showing armed warders in charge of the convicts who are clad in a drab uniform marked with broad arrows, and who are quarrying the stone.

Portland Stone is much used in building, and some of our finest public buildings are built entirely of it. Often, too, the facings of large buildings, such as museums, free libraries, town halls, and so on, are of Portland Stone. The stone has the peculiar characteristic of being comparatively soft when quarried, and of hardening considerably when exposed to the atmosphere.

As we walk around the yards we are reminded of the

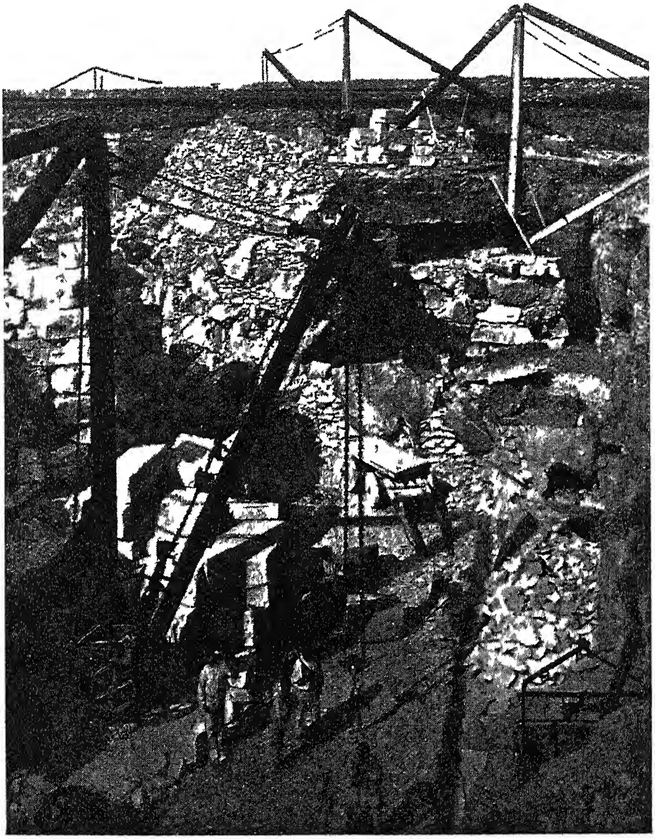
great London architect, Sir Christopher Wren, who, you remember, planned many of London's public buildings, including St Paul's Cathedral, after the Great Fire of London. Wren paid several visits to the Portland quarries, and on certain blocks of stone, which are still to be seen in the yards, Wren's private mark may be distinguished.

The Isle of Portland is bleak, barren, and almost treeless, for the soil is so poor and scanty that it will not support the roots of growing plants. A bird's-eye



CHESIL BEACH FROM PORTLAND

view of the peninsula shows us some typical industrial scenery. Huge slabs of roughly-carved stone are stacked high up in the air; enormous cranes and derricks swing their weighty loads; motor-lorries and traction-engines draw the stone from place to place; light railways run in all directions; and yawning quarries may be seen all around. Now and again the air is rent with the sound of a mighty explosion, for far down in some quarry the rock is being blasted. There is, too, that very unmusical sound of stone-sawing, similar, but a hundred times more intensified, to that heard in a stone-mason's yard.



[Photo, Frith & Co Ltd

PORTLAND QUARRILS

When a new quarry is opened the *overburden*, that is, the top soil, is first removed. This top layer is of varying thicknesses, ranging from twelve to thirty feet. Under-

neath the overburden there is a seam which is known as *soft burr*. This is about eighteen inches thick, and is composed of various rocks. Immediately underneath the soft burr we come to a layer called *black dirt* also about eighteen inches thick. Then come eight or nine feet of hard mud, known as the *top cap*, followed by the *skull cap*, which consists of three or four feet of softer mud. Just below this there is a very curious rock deposit, known as the *roach*. This consists of myriads of fish fossils, and it has been formed, during countless centuries, by the skeletons of marine animals.

The real stone, which is a deposit of Oolitic limestone – that is, limestone formed of small bodies, such as the roe of a fish, cemented together under enormous pressure —lies just beneath the roach. In some quarries it is arranged in layers over thirty feet thick.

To remove the stone wedges are driven in wherever a crack or chink is seen in the bed. Heavy hammers, wielded by brawny arms, drive the wedges farther and farther into the crack, and soon a solid mass of stone, weighing, perhaps, several tons, is loosened A crane is then swung round and the block of stone is raised on to a trolley or wagon, which runs it off into the works, where it is shaped by a steam saw, and smoothed and polished by a mason.

CHAPTER XVII

HOW CRICKET BATS ARE MADE

MOST boys are fond of cricket, and when you grow up you will have your favourite bat. Should you ever develop sufficient skill to take part in first-class cricket you will be very fastidious over your choice of a bat. Some of our leading cricketers look upon special bats as mascots; they would never play in an important match without them. Heroes of scores of 'centuries,' with their battered blades bound in all parts, they are able still to defy the bowler's tricks, and clump 'four' after 'four' to boundary.

It is certain that you would like to know how a cricket bat is made, and as there is a factory not far from the place where this book was written, you must come with me in imagination and see the manufacturers at work on King Willow.

The first thing we notice on entering the yard is a number of blocks of wood stacked one above another on the flat roofs of the various sheds. Each block is a rudimentary bat, and it is necessary that the wood should lie out in the open for about twelve months so that it is seasoned. Any cabinet-maker or carpenter will tell you that 'green' wood—that is, wood which has been recently felled, and which still contains sap—has to be seasoned before it can be made into furniture. While the seasoning process is going on a great deal of sap oozes

from the wood, and if a block of wood be weighed before and after it has been seasoned, there will be a great difference in the weight.

We wonder where the wood comes from, and the foreman tells us that the trees are mostly felled in Norfolk,

FELLING ASH FOR MESSRS BUSSEY

Suffolk, and Essex. They belong to one special branch of the great Willow family, known by the Latin name of *Salix alba*, that is, the 'white willow.' This tree is so called because of the light under surface of the leaves. The man who is sent down to East Anglia to select the trees has a very responsible position, for upon his selection much of the success of the factory depends. He usually chooses the trees in late autumn when the leaves have

been shed, and he can inspect the trunk thoroughly. There are many things which influence him in his choice. He prefers trees with large boles, as only the trunk is used; the trunks must also be as straight as possible; and the best wood is obtained from those willows which stand on dry ground You know that most willows

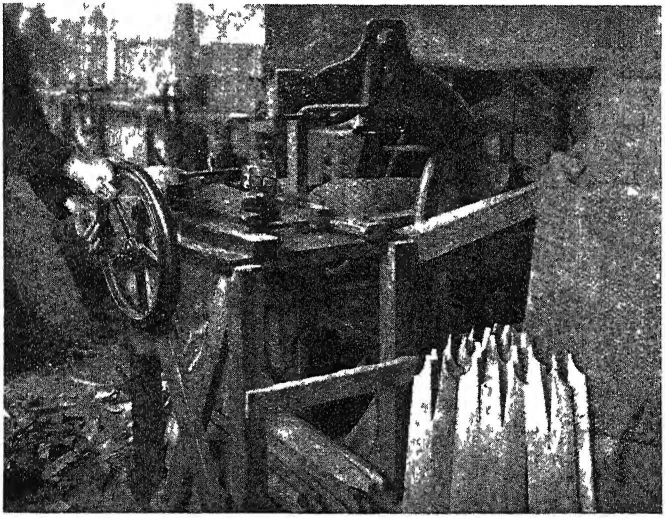
CHOPPING THE WILLOW LOGS INTO 'CLEFTS' AT MESSRS BUSSEY'S WORKS

grow in damp, marshy soil, and this makes the wood very sappy in texture. The ideal willow is that which grows a few yards away from the damp ground, but yet is sufficiently near for its long roots to tap the moisture of the marsh. Those trees which have been attacked by insects, and afterward by woodpeckers, are rejected.

The scarcity of suitable timber has long been a difficulty to the manufacturer of cricket bats. When you remember that hundreds of thousands of bats are made

every year, and that our cousins in Australia and South Africa use cricket bats made from East Anglia timber, you will understand why a high price has to be paid for a good cricket bat.

After a selection of trees has been made the timbermen



Cutting out for the Splice at Messrs Bussey's Works

fell them with saws. As the very best bats are made from the wood nearest the bottom of the trunk, care must be taken that the trunk is not unduly hacked by an axe. As soon as the tree has been felled the branches are cut off, and the trunk is quartered. The logs are then taken to the factory, and workmen shape them into *clefts* about the size of a cricket bat. Many trees show serious flaws in the timber when they are being shaped.

The chief defect is a large knot, and no first-class bat is produced from timber containing knots. Great skill has to be shown in 'clefting' the wood, and certain men in the factory do nothing but cleft and season the wood.

After being freely exposed for a year to sun, wind and rain, the cleft is removed to the workshop. Here it is put into a vice and cut by a sharp two-handled tool into the rough shape required. Much care has to be shown in shaping the blade. The thickest part of the bat, which is generally about five or six inches from the bottom of the blade, has to stand out with a smooth, even grain, and the shoulders must be evenly curved.

The next stage is that of *pressing* This is done by a strong roller which mangles the blade and makes the timber very compact. That part of the blade which will have most wear is pressed much harder than the shoulder-part of the bat. A workman tests the wood by striking it a few times with a heavy hammer, and if the wood is dented it has to be pressed again. Perhaps you have noticed many dents in the blades of cheap toy bats. You may be quite sure that a shilling bat was not made from the trunk of the *Salix alba,* nor was it put through the press many times.

After the pressing has been satisfactorily done, and the sides and end hammered, the blade is *wedged.* The wedge is cut out by a very sharp saw from the top of the blade, and it is now ready for *handling.*

Perhaps the handling of a bat is the most important part of the manufacture. You all know those nasty jars which are experienced when a bat which has a bad handle is used. You feel afraid to give the ball a good clump, as the concussion gives your wrists and arms quite a shock.

Some of the final stages in making a Cricket Bat at Messrs Bussey's Works

The handles of good bats are all made of cane, most of which comes from the Straits Settlements. Each length of cane is cut into strips of about fifteen or sixteen inches, and every strip is made square by slicing off the rounded sides. The strips are then glued together so that they form an oblong bar of cane about two inches square by sixteen long.

The handler makes first a wedge-shaped point to one end of the bar. This must be done by paring the cane, which is gripped by a vice, very smoothly and evenly. After much careful labour has been expended on the *splice*—as the wedge part of the handle is called—and the wedge in the blade has been delicately chiselled, the handle is driven into the blade, and the splice is fixed with very strong glue.

As soon as the workman is sure that the jointing of blade and handle has been well done, he proceeds to shape the handle. This is done first with a lathe, and finally by hand. The blade is next sand-papered and polished. The polishing is done by a piece of smooth bone, very similar to that used by the shoemaker for polishing the sides of new boot-soles.

The final operation is that of binding the handle. This is done by placing the handle in a lathe, and as it revolves the waxed thread is wound on very tightly. Great care has to be exercised in fastening the thread, as a bad fastening would soon make the thread become loose.

CHAPTER XVIII

COPPER, TIN, AND LEAD

In speaking of minerals it is customary to class tin, copper, and lead by themselves; when we think of tin our minds turn at once to copper, and then to lead. Possibly this is because the metals are usually found lying closely to each other in the earth. Thus a copper mine is often adjacent to a tin mine, and lead is sometimes worked in the same locality. Copper and tin, too, are combined into that most useful of metals—bronze—of which our pennies are made.

Our history books tell us that in very remote ages this country was famed for its tin, and that the Phœnician and Carthaginian sailors undertook perilous voyages across the sea to the Cassiterides, or 'Tin Islands,' in search of it. For thousands of years tin has been worked in Cornwall, and though of late years many of the Cornish mines have been closed down because of the great cost of labour in mining this ore when compared with that in foreign mines which have recently been opened up, yet there is such a great demand for tin that it is thought that the Cornish tin industry will become active again. Though millions of tons of tin ore have been extracted from the Cornish mines, they are by no means worked out, but of course the ore is more difficult to reach than was formerly the case.

The chief seat of the Cornish mining industry is

Camborne, although St Just, a village about seven miles from Penzance, has the famous Botallack mines in the vicinity. These mines are many fathoms deep, and the workings are under the sea. The Dolcoath copper mine at Camborne is over two thousand feet below the surface, or about twelve times the height of Nelson's Monument in Trafalgar Square, London.

Many years ago Devonshire had rich mines of lead, copper, and tin in the district around Tavistock, but not much ore is mined there nowadays. Lead-mining is carried on mainly in the Isle of Man, Derbyshire, Durham, and North Wales.

Tin ore is found embedded in the earth's crust in the form of veins, or streaks, which are often only two or three inches wide. The miners follow the course of the veins as closely as they can, but the various strata, or layers of rock, have become much twisted and broken, so that the veins are often difficult to trace. It is much easier for the coal-miner to follow the course of a coal seam than for the tin-miner to keep to a vein of tin. But the tin-miner has no dangerous gas to encounter, and he can work quite safely with a naked light. In many cases rough candlesticks, containing lighted candles, are fixed to the miners' hats when they are at work in the mine. Tin-stone occurs in deep lodes blended with other metals, such as arsenic, copper, or zinc, and it is of a reddish colour, so that the miner's clothes have a rusty appearance when he comes to the surface.

The rough ore as it leaves the ground looks very unlike the white tin of commerce. It is first hammered and smashed by stampers, and then it undergoes the first stage of smelting. This is usually done near the mine, for the cost of the carriage of tin ore to Swansea, the

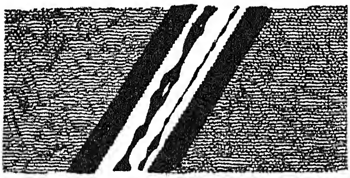
great copper and tin-smelting centre of Britain, would be much heavier if the stone and other waste materials were not removed. After it has been smelted for the first time, and the stone removed, it is made into rough lumps called block-tin. The block-tin is sent to Swansea to be again smelted and refined, when it is made into tin-plate. Tin-plate is formed by dipping thin plates of iron into molten tin, then cleaning them with sand and afterward steeping them for several hours in water which has in solution some cleansing agent, such as sulphuric acid. Many of our kitchen utensils, such as saucepans, boilers, and so on, are made of tin-plate; if they were made of iron only, they would rust.

Thousands of people in Swansea are employed in various branches of the smelting industry About two hundred years ago some copper-works were established here, and since then the town has grown very rapidly. It owes its prosperity to its situation near the centre of the South Wales coal-field, for, without an abundant supply of coal, smelting could not profitably be carried on. The town has an excellent situation on the Bristol Channel, and thus faces the great copper-producing countries, such as Spain, America, and parts of Africa. Cornwall and Devon, too, are within easy access. When the copper-works were first opened up at Swansea nearly all the ore smelted was obtained from Cornwall and Devon, but as there is little mined in those counties now, most of Swansea's supply comes from abroad.

Copper is found usually in the form of ore, which contains sulphur, iron, and many other metals and rocks. 'Native,' or pure copper, is sometimes discovered, and blocks of native copper weighing several tons have been mined. It is thought that the copper used in the making

of bronze by our prehistoric forefathers was 'native,' for at that period, known as the Bronze Age, it is extremely probable that there were no means of smelting metals in this country.

There are two methods generally employed in smelting copper ore. These are the 'dry' and the 'wet' processes. Both processes are used, but the latter only very rarely. In the former the ore is roasted and then smelted with agents which form a slag, or scum, with some of the impurities. The result is *blister copper*; this in turn is further refined, in order that the sulphur, arsenic, and other impurities may be removed. When the metal has been sufficiently purified it is cast into ingots, or small bars of uniform size.

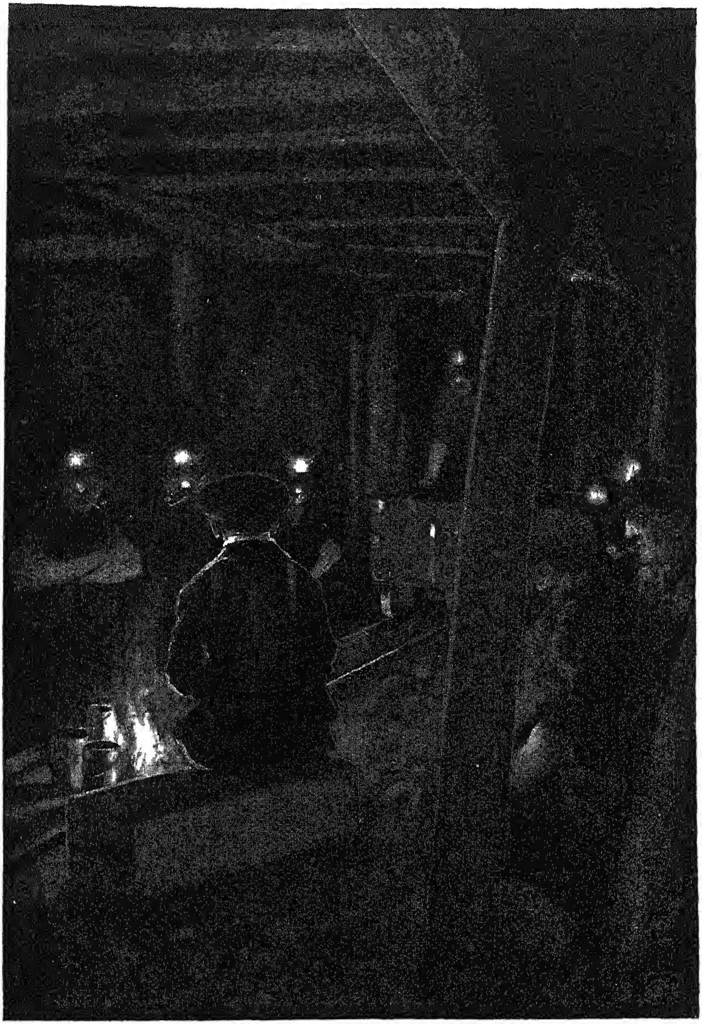


Rich part of Vein or 'Lode

Lead-mining has been carried on in various parts of this country for many centuries. It is known that lead was worked in Derbyshire by our Roman invaders nearly two thousand years ago. This metal is found in veins in very old rock formations, and it is combined with a large number of different minerals.

Silver is usually found associated with lead. In the process of purification of the ore by heating it in a specially constructed furnace, the workers are sometimes afflicted with one or more forms of lead-poisoning. Plant life, too, suffers in the vicinity of a lead furnace, for the smoke carries off particles of the lead and its harmful impurities, and the leaves are poisoned.

Britain does not produce lead in sufficient quantity for her needs, and we import ore from the United States,



Stephen Reid

AFTER DINNER IN THE LEAD MINE

Australia, and other countries. After it has been purified we export many articles of manufactured lead, such as lead piping used by plumbers, and various alloys of this metal The Laxey mines on the East Coast of the Isle of Man, and the Foxdale mines in the west of the Island have produced large quantities of lead. In 1910 there were mined in the United Kingdom 21,522 tons of lead ore valued at £283,194, 4,797 tons of tin ore, valued at £738 025; and 449 tons of copper ore, valued at £27,570.

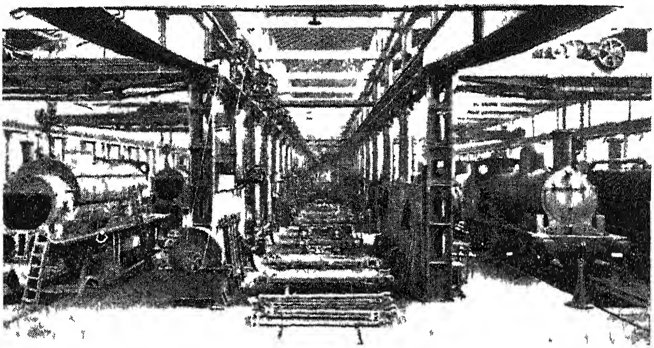
CHAPTER XIX

ROUND THE WORLD'S LARGEST RAILWAY WORKS

THREE-QUARTERS of a century ago there stood in rural Cheshire a farm-house and three or four cottages which formed the tiny village of Crewe. The few labourers who lived in this village were engaged in farming, while their women folk made butter and cheese. Little did these people think that Crewe would soon be famed all over the kingdom as the centre of a great railway works, and that the few cottages would grow into a mighty industrial town containing row after row of small two-storied houses where would dwell an army of railwaymen and their families. All that remains of old-world Crewe is a seventeenth-century black-and-white-timbered house with a thatched roof. This is the only house in the district over three-quarters of a century old, and it forms the office of a cab and motor proprietor

It is said that the London and North-Western Railway maintains Crewe, and Crewe maintains the London and North-Western Railway. Certainly the railway employs most of the workmen, either in the works or on the line, and it finds dwellings for 16,000 or 17,000 railway workers. In the works alone there are employed between 8000 and 9000 men. Nearly everything in Crewe belongs to the Railway. Gas is made and supplied by the Railway Company, and the town derives its water-supply from the Company as well.

Surely those village labourers of eighty years ago would have thought they were in fairyland if they had been in Crewe when King George visited the town in 1913! From Crewe Station to the point where the King entered the Railway Works is two miles, and for the whole distance the track was lined by artisans from the various shops, standing shoulder to shoulder, ready to greet the King as he passed. April 21st, 1913, was a

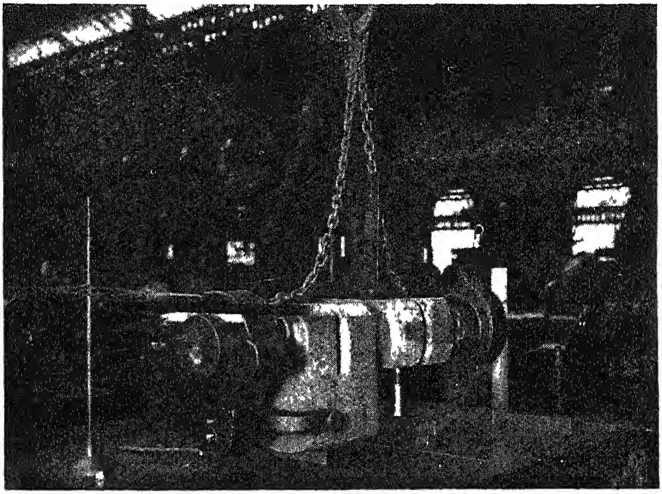


SHOWING LOCOMOTIVES IN COURSE OF CONSTRUCTION AT THE L. & N.W. RAILWAY WORKS, CREWE

red-letter day in the history of Crewe, and in honour of the King's visit nearly every house along the route was gay with bunting of some kind or other. Triumphal arches, mottoes, banners of curious designs, and flags innumerable, welcomed King George, and the railway offices provided a striking object lesson by the three small engines on their roof, labelled "1829," "1847," and "1913."

Apparently the main object of the directors of the London and North-Western Railway was to bring to the

royal notice the remarkable evolution of the railway-engine. One of the first objects which the King inspected was a model of Stephenson's *Rocket*, and, by way of contrast, one of the modern 'Claughton' locomotives was drawn up just behind. What a frail little engine

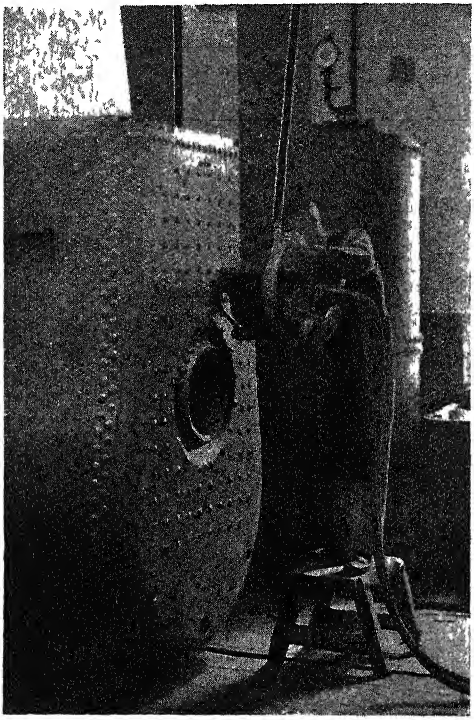


SETTING AND MARKING OFF A LOCOMOTIVE CRANK AXLE PREVIOUS TO MACHINING AT L. & N.W. RAILWAY WORKS, CREWE

the four and a half tons Rocket looked beside the mighty Claughton, weighing 117 tons! To provide a contrast between the means of travelling a few centuries ago and those in vogue nowadays, Queen Adelaide's state coach was placed in the rear of the Claughton engine.

The next visit was to the erecting shop, where His Majesty inspected nine modern engines in various stages of construction, and the work had been so arranged

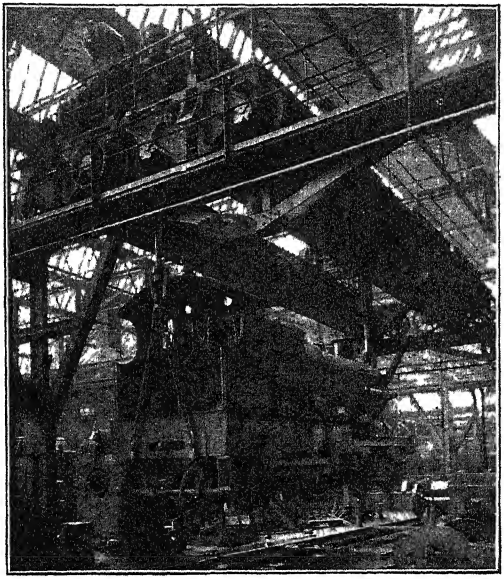
that the first engine contained merely the skeleton of her frame, while the last was nearly complete.



LOCOMOTIVE FIREBOX, SHOWING THE COPPER STAY-HEADS BEING RIVETED OVER BY A PNEUMATIC RIVETING MACHINE AT THE L. & N.W. RAILWAY WORKS, CREWE

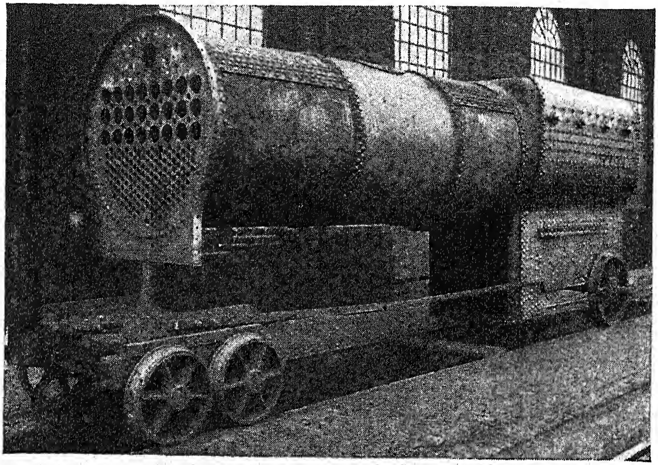
From here the royal party journeyed to the boiler shop where they experienced the deafening sensation induced by the din of the riveters at work on boiler-plates.

Those who work in a riveting shop soon become used to the vibrating shocks, and they suffer little discomfort from the noise, but a visitor will probably have a severe headache if he stays long near the riveters.

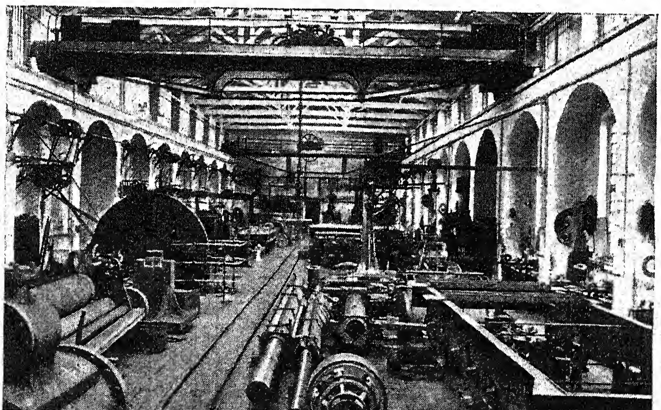


A POWERFUL OVERHEAD CRANE AT THE G W RAILWAY SWINDON WORKS

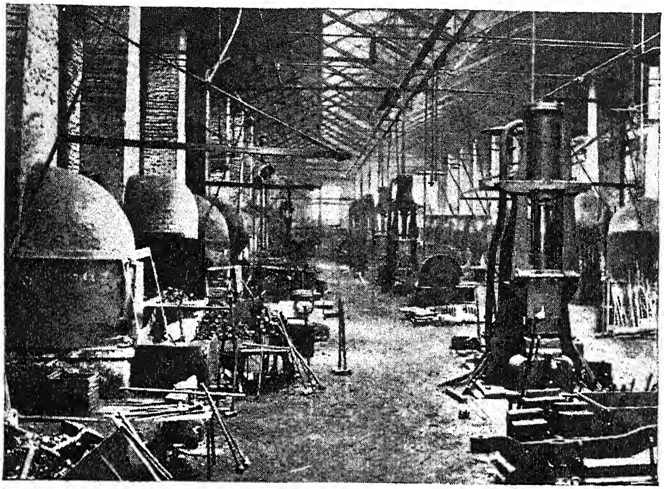
Many other shops were visited where there were in process the rolling of axles, the tyring of wheels, the making of nuts and bolts, the laying down of points and crossings, the construction of flanges, and every part of the industry connected with the railway-engine. It is estimated that 3000 locomotives are repaired at Crewe



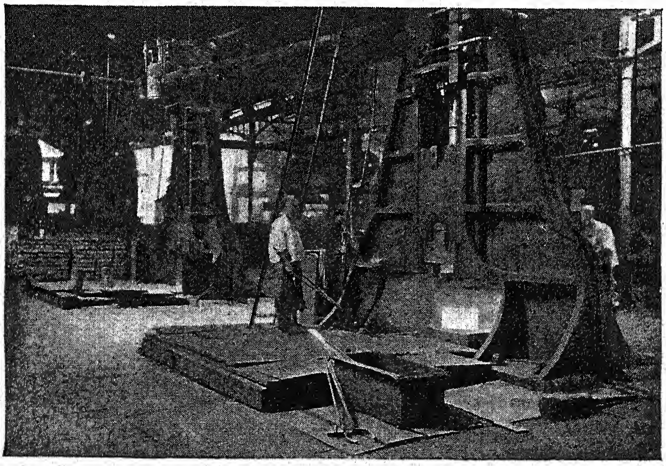
Locomotive Boiler as it leaves the Boiler Shop at the L. & N.W. Railway Works, Crewe



One of the 'Shops' at G.W.R. Swindon Works
(See Overhead Crane driven by Electricity)



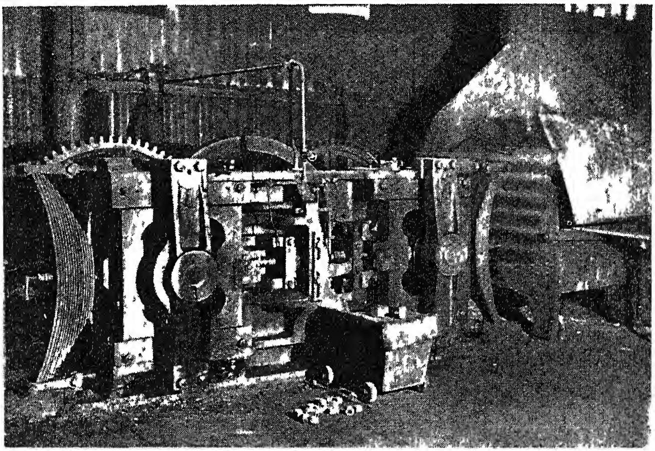
Smiths' Shop at G.W.R. Swindon Works



Steam Hammer at G.W.R. Swindon Works

every year, and the number of engines in the yards generally exceeds two hundred ; one can obtain a faint idea of the vastness of the works when one reads that the boiler shop alone measures 673 feet long and 107 feet wide, and altogether the sheds cover 138 acres of space.

Science has made such rapid progress in the construc-



NUT-MAKING MACHINE AND OIL FURNACE AT G.W.R. SWINDON WORKS

tion of locomotives and rolling-stock during the last fifty years that many thousands of workmen are engaged in the various railway works throughout the country. For you must remember that Crewe supplies only the demands of one special railway company. Similar yards to those at Crewe may be seen at Peterborough, where the railway works of the Great Northern Railway Company are situated ; at Swindon, where the rolling-stock of the Great Western Railway Company is made ;

at Eastleigh, where are situated the works of the London and South-Western Railway; at Stratford, Doncaster, Darlington, and other industrial towns.

Crewe specializes in the railway-engine; the carriages are made at Wolverton, and the coal-wagons and goods-trucks at Earlstown, both towns belonging to the London and North-Western Company. A complete engine was once turned out at Crewe, passing through all stages of construction, in twenty-five hours.

CHAPTER XX

ROUND A ROYAL ARSENAL

It would be well for us in our industrial journeys to visit one of our great national workshops where the arms of the nation are made. We have already spoken of that terrible engine of destruction, the modern *Dreadnought*, and you will be interested in watching the men who fashion her weapons, and in seeing a little of what modern industry, modern science, and modern invention, as applied to armaments, have devised.

There are several small arms factories scattered about the country, but our journey to-day is to the Royal Arsenal at Woolwich, in the south-eastern suburbs of the Metropolis. For many years this has been the nation's most important arsenal, and it is only fitting that it should stand near the heart of the mightiest city in the Empire, and on the banks of Old Father Thames.

You have been taught, and rightly taught, to look upon Kent as a county containing beautiful scenery, blossoming orchards, numerous hopfields, pretty villas, sparkling rivers, and pleasant dales and dells. Your minds turn to the beauties of old-world Tonbridge and peaceful Canterbury, and you, who live at a distance, cannot imagine any part of Kent where dingy, drab factories are to be found. But the scenery about and within the Royal Arsenal is by no means beautiful.

Running alongside the main street of Plumstead—

which is really a suburb of Woolwich—is a tall, dirty, blank wall, which screens completely the numerous workshops within. If one walks by the Arsenal gates during the daytime when the men are at work inside, there is little sign of life. Two or three policemen, with one or two officials, stand at each gate, and as the visitor

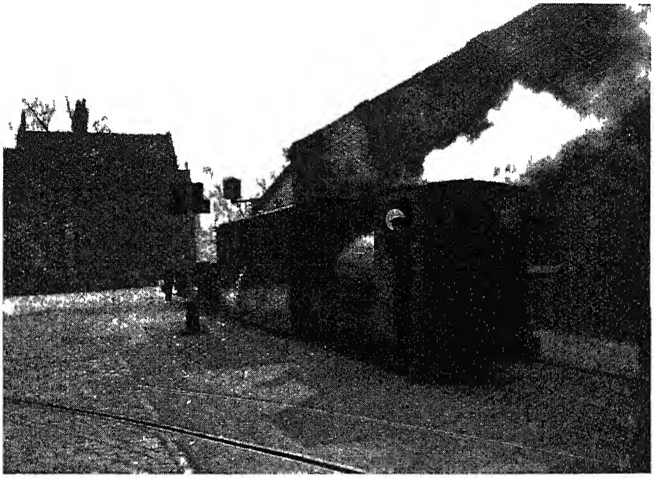
[*Photo, W. H. Smith & Son*

MAIN ENTRANCE TO WOOLWICH ARSENAL

looks through the gate, he sees a long straight road running away toward the river, with other roads running at right angles to it, which lead to the various factories.

But let the visitor stand near the gate at the time when the men are leaving work, and he will have some idea of the number of men who are engaged in making the nation's weapons. The main road inside the Arsenal

becomes black with men, as each smaller road, like the tributary of a mighty river, pours its torrent of weary toilers into it. It is no easy task to move along the narrow Plumstead High Road when the Arsenal workmen are leaving, and the writer has on several occasions been almost as effectually marooned on the top of a



[Photo, W H. Smith & Son

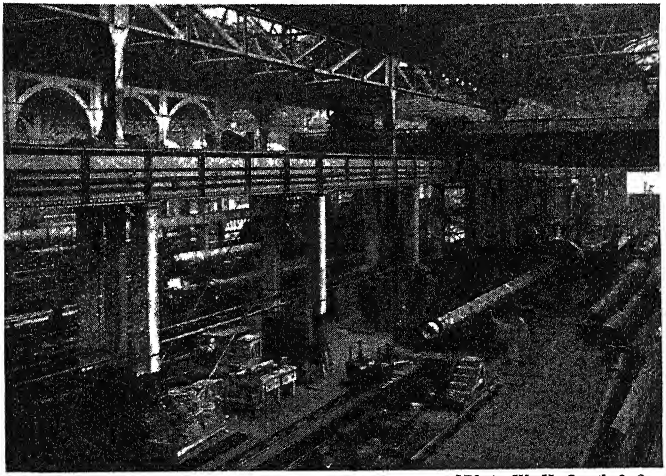
RAILWAY, WOOLWICH ARSENAL

tram-car outside the Arsenal, at closing-time, as a derelict on a hidden sand-bank.

Those of you who journey to Plumstead in the hope that you will be allowed to walk round the Arsenal, as easily as you may walk into the Woolwich Free Library, will be sadly mistaken. At least, you may walk round it, but it will be from the outside only; before you obtain admittance you must show a written

permit, which is by no means easy to obtain. However, we will assume that we have the necessary permit, and have passed the gloomy portals with their stalwart sentinels, who, by the way, have inspected us very closely indeed.

Those of us who have been in other centres of industry



[*Photo, W. H Smith & Son*

SOUTH BORING MILL WOOLWICH ARSENAL

are not disappointed at our first view of the sombre-looking buildings. The Arsenal is made up of dozens of buildings, each of which is used for some special branch of work. In the West Forge of the gun-factory we see the powerful three-thousand-ton forging press at work on the jacket of a large gun; and in other rooms we watch the boring, rifling, and turning of heavy 13½-inch guns, which, when finished, will

each weigh 75 tons, and cast a shell 1250 lbs in weight.

Here we have a large carpenter's shop, and over there a painter's shop, where gun-carriages, various vehicles, and boxes by the hundred are made and painted. In the steel foundry we almost imagine we have been transported to Middlesboro, or Barrow-in-Furness, for we see similar convertors with charges of steel in process of blowing. Many of the factories are engaged in various branches of the shell-making industry. The huge shells have to be turned, and banded, and charged with lyddite, and all these operations require skilled workmen.

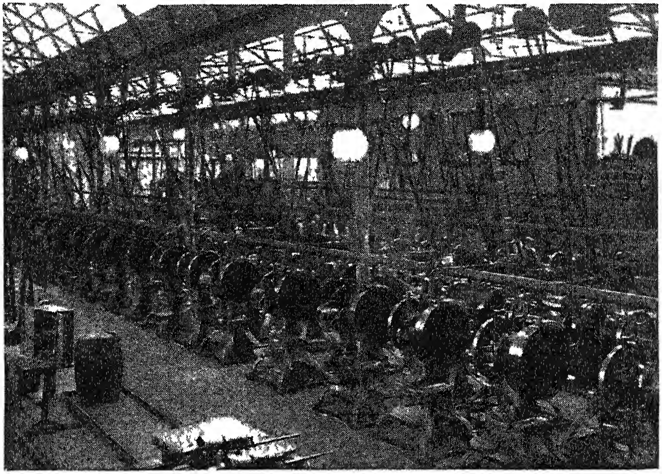
In one factory we can see men winding the cordite on long reels much in the same way that a sailor uses the windlass in winding up the cable. Cordite is gun-cotton which has been treated with nitro-glycerine, and it is in the form of greasy cord. Gun-cotton is cotton waste subjected to the action of nitric acid, washed, boiled, pulped, and finally pressed into blocks.

You would be interested in watching the giant steam-hammer at work, for this hammer has a striking power of a thousand tons, and one blow from it is sufficient to flatten a ball of iron into a plate resembling a pancake.

As we walk through many of the workshops we are amazed at the precision and rapidity of the numerous automatic machines which have supplanted hand labour but which require skilled engineers to keep them in order. There are machines, some of which are worked by lads, for the manufacture of bullets; indeed, most of the processes involved in bullet manufacture, from the initial squirting of the lead cores to the completion of the bullets, are done by machinery.

One of the most interesting buildings is the Royal

Laboratory. Here, again, the automatic machine is installed for the making of fuses, which, of course, forms one of the most important parts of the shell. In this building there may be seen very highly-skilled workmen. There are some of the most clever mechanics and engineers found in Britain employed in the Royal Arsenal. What



[*Photo, W. H Smith & Son*

BULLET FACTORY, WOOLWICH ARSENAL

terrible powers they have at their command too! Electrical power, hydraulic power, the power of compressed air, chemicals of all descriptions, deadly explosive mixtures, stores of gunpowder—all are to be seen in the Arsenal!

Dotted at intervals along the banks of the Thames outside the Arsenal are the square, squat, red-bricked powder-magazines, and on certain days one may hear

the booming of guns across the wide marshes which extend from Plumstead to Abbey Wood. This proclaims the sight-tester at work, and very important work it is too. In the big modern guns it is said that an almost microscopic difference in the tilt of the gun will cause the shot to fall, say, 8000 or 8100 yards away, and, of course. however straight the shot may be, an error of 100 yards in length would probably cause it to fall short of, or go beyond, the target. Firing and testing practice is not altogether appreciated by the inhabitants of places near the Arsenal, and even at Belvedere, four miles distant, several windows have been cracked by the air-blast caused by the firing of heavy guns.

As we leave the Arsenal we reflect, somewhat sadly, on the necessity of the manufacture of these terrible engines of destruction, and we think how much better it would be if the organising ability of those in charge of the Arsenal could be turned into some other channel. But so long as the fighting instinct of primeval man continues in the human race; so long as envy, hatred, malice, and allied sins exist between rival nations; then most assuredly we must continue to manufacture these terrible machines of war—'fiends incarnate,' as they have been described.

Our Royal Arsenal is in a high state of efficiency, and King George, during a visit there in 1913, paid the workers a graceful tribute when he said: "I am glad to assure myself by personal inspection that the Royal Arsenal is maintained in a state of activity and efficiency. Upon the constant and devoted labours of those who direct and those who are employed in this great national workshop depends in a high degree the effectiveness of my Army and Navy."

CHAPTER XXI

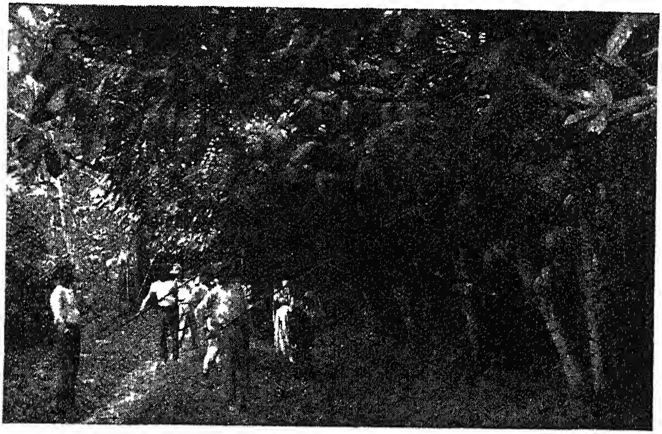
IN A CHOCOLATE FACTORY

IN our journeys through industrial England it would be interesting and instructive to take a peep inside a large factory where chocolate is manufactured, in order that we may see how the workpeople, most of whom are women and girls, make that delicious confectionery which is so tempting both to palate and eyes.

A bar of chocolate has travelled some thousands of miles and passed through scores of hands before, in its final state, it is displayed in the confectioner's shop. First, it grew on the cacao-tree, probably in the West Indies, in the form of a kernel, or small bean, enclosed in a pod. Hundreds of thousands of cacao-trees grow in the hot climates of the West Indies, Central America, and Central Africa, and the large pods hanging on the trunks of the trees look something like marrows.

The natives gather the pods by cutting them from the stems of the trees with a kind of shears fixed to a long pole. You may have seen the gardener trimming and lopping the trees in autumn with a similar contrivance. The pods are laid out on the ground for a few hours to dry, and then they are split and their beans extracted. The beans are then laid in shallow boxes and exposed to the fierce rays of the sun; to ensure that they are thoroughly dried they are turned from time to time. If we tasted the bean at this stage it would appear oily and bitter.

One of the first operations after the beans have arrived in the English factory is to roast them. This is done by placing them in large shallow boxes which are arranged over gas-fires. A man turns them over and over, one upon another, so that all get their share of heat. The taste of a roasted bean is quite different from that of a bean in its natural state.



CUTTING THE PODS IN MESSRS CADBURY'S TRINIDAD PLANTATIONS

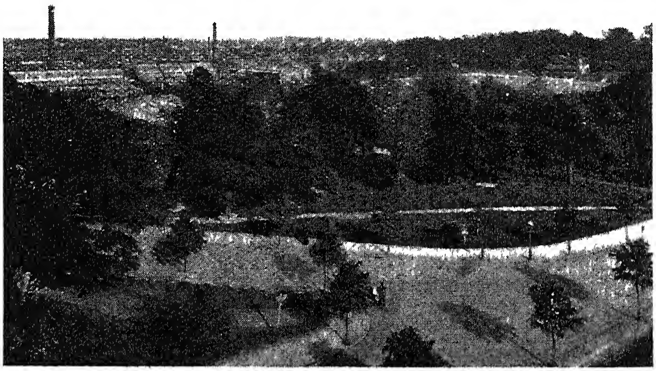
After the roasting has been satisfactorily carried out, the beans are ground in a mill to fine powder. Fine sifted sugar and other flavouring agents, such as vanilla or cinnamon, are added to the powder, which is afterward run through a mill containing a steam-heated chest. As a result of the great heat the powder is melted into a thick oily fluid, which runs into cans and is taken to the moulding-room.

The manufacture up to this point has been fairly simple, but we have now arrived at the stage when great skill

Roasting the Coco Beans at Messrs J S. Fry & Sons, Ltd

is necessary Rows of girls, with neat white 'bakers'' caps on their heads, stand before benches on which are arranged moulds of various shapes and sizes The girls scoop the liquid from the cans which stand in front of them on to the moulds, which are placed aside to cool.

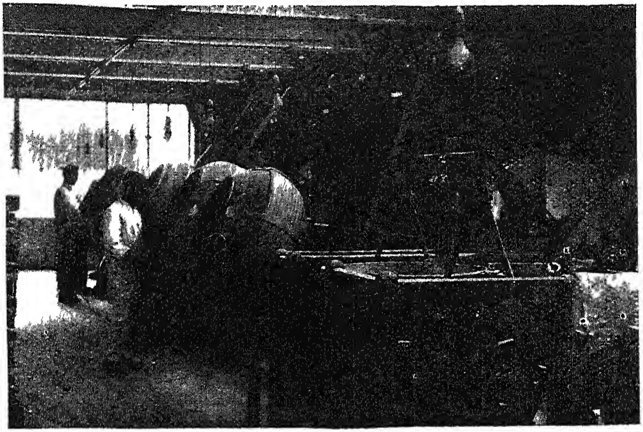
Have you ever wondered how the cream, almond, or nut got inside the chocolate? Suppose chocolate creams are required The girls make the cream by



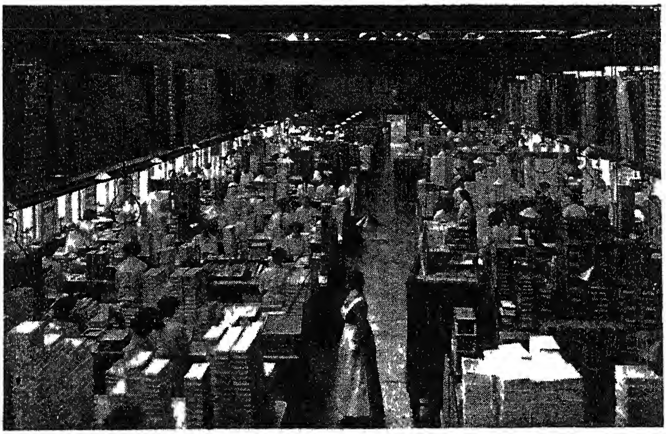
MESSRS CADBURY'S WORKS AT BOURNVILLE

whipping up a special kind of sugar into a creamy white paste by the aid of a rapidly revolving whisk The cream is quickly fashioned into the required shape, and then thrown into pans of liquid chocolate All that is now necessary is to take the coated creams out of the pans and lay them to drain and harden on wire gratings. A similar process is adopted with nuts, sweets, almonds, etc

Easter eggs, which have a great sale at Easter-time, are made in two halves by the aid of hoops of smooth cardboard, which form serviceable moulds. By making



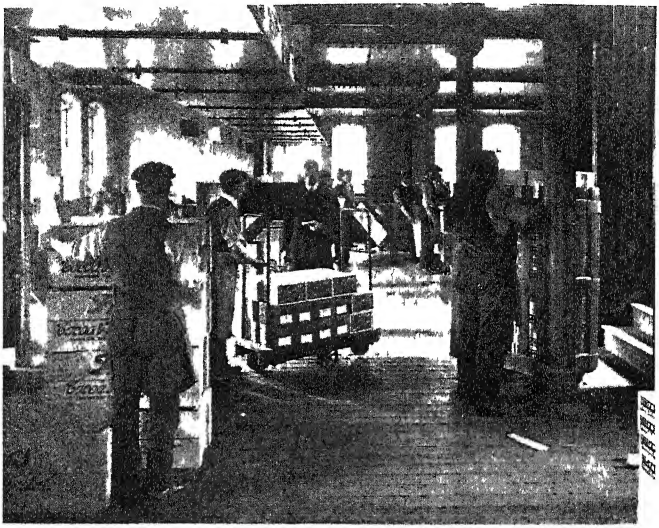
THE ALMOND COVERING ROOM AT MESSRS J. S. FRY & SONS LTD.



PACKING CHOCOLATES AT MESSRS CADBURY'S BOURNVILLE WORKS

the eggs in this way small and novel gifts may be inserted in the egg. If you closely examine an Easter egg you will see where the two halves were joined.

Not the least important part of the work is the packing of the chocolates. In some factories this is done partly by an ingeniously-contrived machine. An endless revolv-



A Stock-room at the London Branch of Messrs J. S. Fry & Sons, Ltd

ing band receives the chocolates, one by one, and they are carried along to a strip of silver paper. The machine picks up each chocolate and wraps it in the paper.

All kinds of fancy boxes, decorated with pretty shades of ribbon, are used in the packing department. The packing is also done by girls, and, indeed, with the exception of the preliminary work of roasting and grinding, all stages of the manufacture are carried through by females.

CHAPTER XXII

A VISIT TO THE MINT

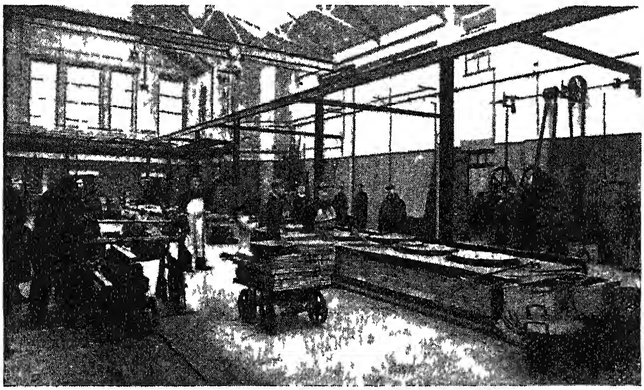
TO-DAY we will visit the great national money factory called the Mint, which stands on Tower Hill, on the banks of the busy Thames. In this solid-looking building all our English money is made, and all the coinage in circulation in this country was manufactured there with the exception of a comparatively few Australian coins.

Many years ago there was a mint in almost every county, and at one time the sovereign, baron and bishop had the right to coin money. In the reign of William III all the county mints were abolished, and special regulations were made by law whereby public authority to coin money could be exercised by one national mint only. You know that, nowadays, if people try to evade the law by coining money, they are very severely punished if detected.

We will trace the making of a shilling, from the time the silver arrives at the Mint from distant parts of the world, until it passes into circulation as a coin of the realm. When the bars of silver have been unloaded at the docks they are taken to the Mint yard, where they are wheeled on trolleys to the melting-house. The rough metal has to be well guarded, for one trolley-load of silver is worth many thousands of pounds

First, the bars, or ingots, of metal are weighed, and

then they are marked. If they are not required for the melting-house they are stored in the strong-room. A burglar would have little chance of breaking into this room, for the door is of immense thickness and it is secretly closed by three ingeniously-contrived locks. Two men only are entrusted with the secret whereby this door can be opened, and, as a further precaution,



[*Photo, Oppenheimer Bros.*

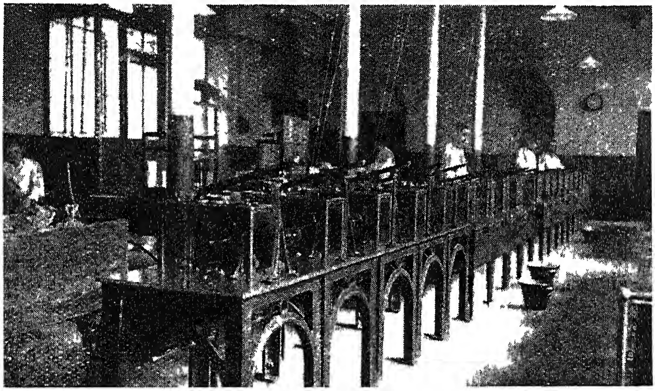
THE MELTING HOUSE

neither of the men can open the door without the aid of the other. Besides being burglar-proof the strong-room is also able to resist fire.

The silver is melted in a closed furnace which has such an extremely high temperature that the metal soon becomes changed into a liquid. The ingots are placed in crucibles which resemble coppers, and after the crucibles are closed they are placed inside the furnace. When melted, the pure molten metal is run into long narrow moulds, and, when cooled, it is in the form of

thin bars Many impurities are extracted from the metal by melting it.

In turn the bars of silver are pressed through five presses which roll them into the thickness of the required coin. They are then cut up into the required size by a machine at the rate of several hundreds in a minute. As the long metal bars are cut up, they fall in a heap and,



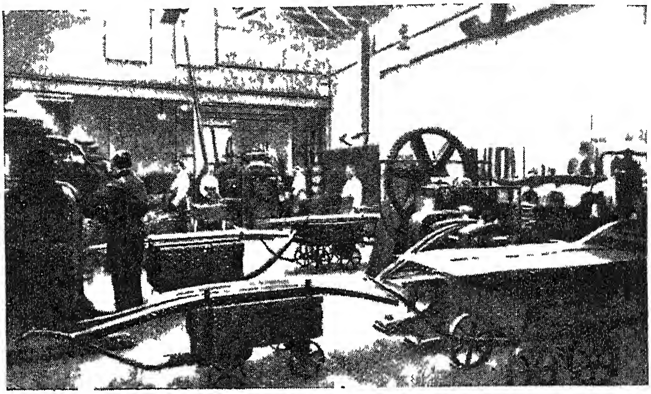
[*Photo, Oppenheimer Bros.*

THE WEIGHING-HOUSE.

so that nothing should be wasted, the residue is taken back to the melting-room and remelted.

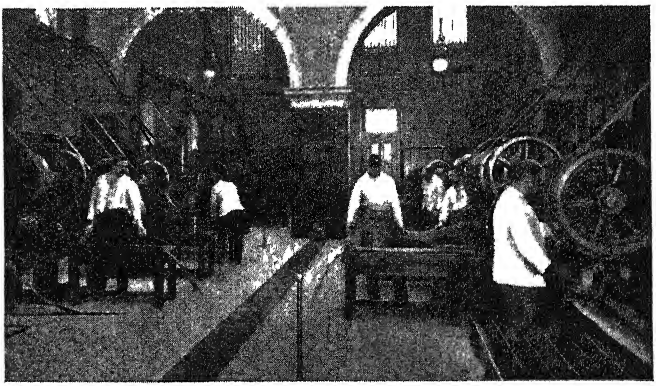
If you closely examine a shilling you will see that the edge is raised slightly. But for this the coin would wear much more quickly. A very complicated machine is used to make a raised edge to the silver disc, and this machine, too, works very rapidly

The blank shillings now have to be well baked and they are placed in small iron boxes which pass through a furnace on an endless chain. When the silver blanks



[Photo, Oppenheimer Bros

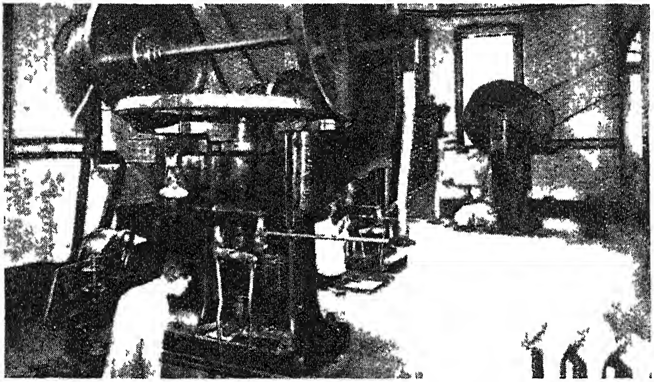
THE SILVER ROLLING ROOM



[Photo, Oppenheimer Bros.

THE CUTTING ROOM

have been thus treated, they are removed from the furnace and placed for cleaning in a copper containing boiling acid. They are next stamped between two dies in a complicated machine. On one side is the portrait of the King, with a Latin inscription, and on the other side is the name of the coin, the year in which it was



[*Photo, Oppenheim & Bros.*

THE MEDAL PRESSES

made, another Latin inscription, and the figure of the British lion standing on a crown.

Now comes the very important work of testing the coins. They are carried off to the testing-room, and a man places them on a slowly-moving belt which passes before a ' tester ' who has a marvellous sense of touch. He touches every coin, and his fingers quickly tell him if any coins are imperfectly made. Those which he rejects are put aside to be remelted, the good ones move slowly along the belt to a tray into which they fall. They are then weighed, and taken to the counting-machine.

The counting-machine is quite the most wonderful machine in the building. It seems almost human; indeed, it is better than a human counter, for he, or she, would make mistakes occasionally, and this machine is always accurate. It not only counts the shillings,

[*Photo, Oppenheimer Bros.*

THE CHANCELLOR BALANCE.

but tests them, weighs them, and drops them into bags ready for circulation.

The bags are taken to the 'circulating' room, and from here they go out into the busy world. Their adventures are numerous and varied, and a true autobiography of a silver coin would probably be most interesting. Gold coins pass into circulation only through the Bank of England.

CHAPTER XXIII

WHERE IRON IS KING

About seventy years ago an ironmaster from the Tyne stood in a quiet little village in the north-east of Yorkshire. To the north of him rose the rolling Durham hills, to the south the long line of the Clevelands, and immediately around him was a verdant valley, with the broad mouth of the Tees preparing to empty itself into the sea.

That ironmaster had come there 'with an eye to business,' as we say. Perhaps, in his mind's eye, he could see that peaceful little village, which day by day sent forth its smacks down the estuary and across the wide stretch of the North Sea to the distant Dogger Bank, becoming the centre of a great industry. Possibly, in his day-dreams, he could see the humble fishermen's and farmers' cottages replaced by rows and rows of two-storied buildings; the clear air thickened with the smoke of scores of furnaces; the silvery Tees a blackened waterway, for ever crowded with barges, and its banks lined with derrick, crane, and wharf.

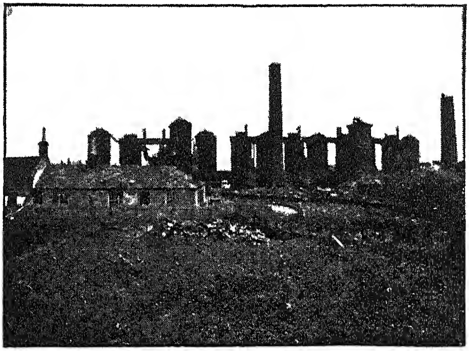
Such is a brief description of Middlesboro before and after the operations of the captains of industry had converted the neighbourhood into the unlovely hive of industry that is to be seen to-day. This part of Yorkshire was an ideal place for the opening up of an iron and steel works. Coal from the Durham coal-field was close at hand, the

valuable ironstone lay buried in the ground all around, the sheltered valley formed a convenient site for workmen's dwellings, and the River Tees provided an admirable waterway on which the products of field, factory, and mine could be transported.

There are few places in Britain which have grown more rapidly than Middlesboro. Less than a century ago the site of this town of over 100,000 inhabitants was occupied by a single farm-house standing in solitude on the wide moors. Since 1840, when the smelting of iron began, enormous blast furnaces have risen in all directions; rolling-mills, foundries, engineering-works, boiler-making works, shipyards, and all the other accessories of the iron and steel industry have been built, and important docks constructed. The streets are well laid out in modern style, and there are the usual institutions of a successful and progressive industrial town.

Let us pay a visit to this fire-blasted land, and see the furnaces fed and the molten metal converted into iron and steel. In our walks through centres of industry we always know when we are approaching a modern manufacturing town, for the houses are so very new and business-like. In agricultural districts they are dotted about here, there, and anywhere, and in most of our beautiful old cathedral towns they have been built in no definite order. But in a modern industrial town the red-bricked and slate-roofed two-storied workmen's dwellings run in parallel rows. There is an unpleasant monotony about them. All are built to the same pattern; usually each has its little flagged forecourt and small back-garden; and there is a perfectly straight line of windows and doors, with no varia-

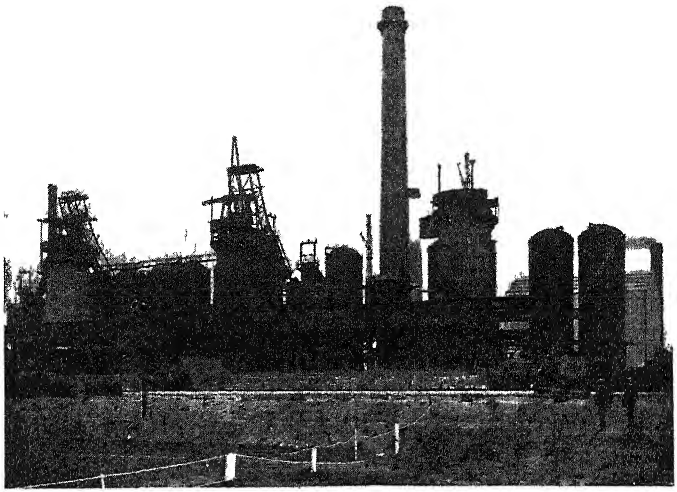
tion whatever—unless a few shops have been built—all the way down the long street. In place of the square-towered, ivy-clad church, with its spacious churchyard filled with yew, cypress, or cedar, and with its pleasant peal of bells chiming out on the restful Sabbath, we find temporary churches, built of wood and corrugated iron, or red-bricked buildings of hideous architecture, which are often left in an unfinished condition in order that they may be enlarged so as to keep pace with the growth of the surrounding district.



IRON WORKS, KILWINNING

As we approach Middlesboro from the Cleveland hills we see just the same sort of buildings that we notice as we approach the busy boot factories of Northampton, the Bessemer steel works in Barrow, the locomotive works at Peterborough, East leigh or Swindon, and the biscuit factory at Reading. Standing up like mighty sentinels are the massive chimney-stalks, and, in iron districts, the broad and tall blast-furnaces, vomiting smoke and fire by night and day, are beacons of an industry famous all the world over. The fiery furnaces are never cooled down; day and night, Sundays and holidays, they are, as one great writer described them, "pillars of cloud by day and pillars of fire by night."

In most of the British coal-fields there are one or two varieties of iron-stone found. These are the *clay-band iron-stone*, where the ore is composed mainly of clay, and the *black-band iron-stone*, where coaly matter is in excess. The ores of iron are very numerous, but the

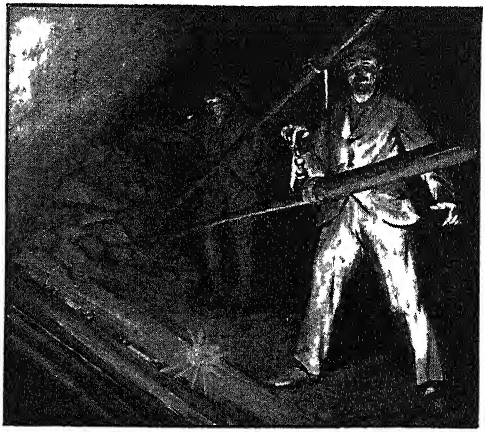


THREE BLAST FURNACES CONSTRUCTED BY THE PEARSON & KNOWLES COAL AND IRON CO. LTD., WARRINGTON

clay-band and black-band ores supply the greater part of the iron mined in Britain.

After the iron-stone has been raised to the surface of the mine, it is run off in trucks to the kiln to be roasted or calcined. The object of this is to separate carbon dioxide, sulphur, water, and other impurities from the ore, and, by making the iron-stone more porous, prepare it for the smelter.

As soon as the ore has been sufficiently roasted, it is run off to the blast-furnace. Lifts raise the ore in barrows to a platform at the top, which is eighty or ninety feet high. Workmen standing on this platform take the barrows of ore from the lift, and wheel them across to the 'bell' in the centre of the furnace-top. Barrow-load after barrow-load of rough-looking ore is shot on to the bell, and when fully loaded this is lowered into the fiery depths beneath.



IRON MINE

Of late years the waste gases of the furnace have been utilized in heating the blast, and in raising steam for the blowing-engine. Formerly the furnaces were open at the top, and the gases burned with a ruddy glow, looking at night like miniature volcanoes. The air-blast, which is propelled into the base of the furnace by a powerful blowing-engine, is heated to a very high temperature. Originally the air-blast was cold, but it occurred to a clever Scotchman, named Neilson, that much better results would be obtained if the blast were heated.

All day and all night the fiery monster is fed, and his food consists of coal, ore, and lime. The coal comes

from the adjacent coal-fields, the ore from the mines many fathoms below the Clevelands, and the lime from the distant Pennines. The furnace is kept filled to within about two feet from the top, and about thirty-six hours are required for the ore put in at the top to be converted into the liquid which flows out at the bottom.

The workmen whose duty it is to feed the furnace from the top have rather uncomfortable surroundings. Standing on the platform, which is raised high in the air, they are exposed to the full force of the wind, and in the winter time the northern blasts, laden with sleet, blow with terrific force over the Durham hills. True, there are little iron shelters where the workmen can take refuge, but they cannot work in these shelters, and so can use them only at mealtimes or at intervals when the lifts are not running. Sometimes, too, a whiff of poisonous gas will escape from the furnace-top, and if the men inhale it they have severe headaches, which may bring on a worse illness, ending in death. Fortunately, though, fatal 'gassings' are very rare.

You would like to be present when the furnace is tapped. Tapping takes place at intervals of about eight hours, and the molten metal is drawn off from a round hole a few feet from the base, called the 'tap.' As the fiery liquid comes through the hole in a steady stream it resembles a dark-red syrup, of a similar consistency to treacle. It runs into channels excavated in sand. At first there is only one main channel about five or six yards long, but at the end there are smaller channels, all made of strong binding sand, lying at right angles to the main channel. These smaller trenches are called 'sows' Each sow, in turn, is also branched into several smaller trenches, and these are known as 'pigs.'

The molten iron is guided from the main trench into the sows, and from the sows into the pigs. All this time the metal has been seething hot, and woe be to the man who accidentally touches it with bare flesh! It is allowed to lie in the sand moulds until it has cooled and become solid, when it is taken out in bars which are known as pig-iron.

But what has happened to the earth and coaly matter and other impurities which were in the ore when it was put into the furnace? All this dross has become united with the lime and other materials which have been shot into the furnace-top, and forms a kind of scum when the ore is melted. This floats on the surface, leaving the heavier metal to sink to the bottom. The scum is technically known as *slag*, and it is drawn off by a tap about nine or ten feet above the base of the furnace. When the slag emerges from the tap it resembles shimmering molten silver.

The pig-iron is usually made into *cast-iron* or *wrought-iron*. To make cast-iron the pig-iron is generally melted in a special furnace, about nine or ten feet high, and the molten liquid is run off into moulds which have the shape of the article required. You know that cast-iron is very hard, but it is also very brittle. Many articles, such as fire-grates, iron pipes, and so on, are made of cast-iron.

Pig-iron contains very many impurities, such as sulphur, phosphorus, and carbon, which lessen the tenacity of the iron and render it unfit to be beaten out into bars or plates. You know that the blacksmith bends and hammers small bars of iron into horseshoes and various agricultural implements. If he had a bar of pig-iron he would not be able to beat it into the required shape; the iron he uses is called *wrought-iron*.

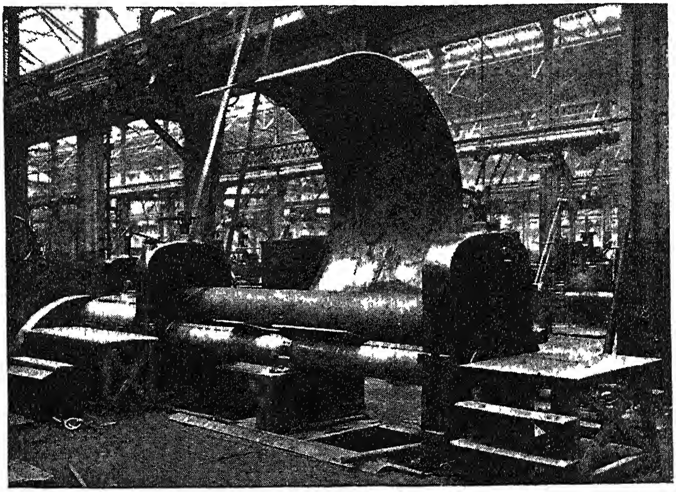
Usually wrought-iron is prepared from pig-iron, but in some cases it is made directly from the ore. The men who make wrought-iron are called *puddlers*, and the furnace in which it is made is called a *puddling furnace*.

To obtain wrought-iron it is necessary to free the metal of sulphur and other impurities which we have mentioned. This is done by the puddler, who works up the molten metal in the puddling furnace into large balls, each weighing about sixty lbs., by means of a long rake, known as a *rabble*. In the furnace there is a hearth, on which the pig-iron is laid, and a fire-place, separated from it, in which the fuel is placed. The hearth is made of several iron plates, and they are so arranged that the air can circulate freely beneath them. Near the hearth there is a door through which the puddler thrusts the rabble and works the iron.

The action of the air on the molten metal produces slag and cinder with the impurities in the iron, and in order that all the metal may come into contact with the air, the puddler first stirs it over and over with his rake. A blue flame burns on the surface of the liquid, and this is made by a gas called carbon monoxide; it is in this way that much of the carbon is removed from the metal.

As soon as the 'pig' has been sufficiently boiled it is worked up by the puddler into balls, or *blooms*, and when all the metal has been 'bloomed,' the door of the furnace is closed, and the temperature raised to what is known as *welding heat*. Afterward the blooms are removed from the furnace with long tongs and taken to the *squeezer* or *steam-hammer*. Here they are beaten into flat cakes, and much of the slag is squeezed out. This process is known as *shingling*. As soon as the metal has been welded into a compact mass it is taken to the

puddling rolls, where it is still further compressed. Next the plates of metal are cut up into suitable lengths, while still hot, by a pair of shears. A certain number of lengths are tied together with iron wire, and then placed in the *mill furnace*, by means of an iron peel. Here they are brought to a high temperature, and when welding



LARGE BENDING ROLLS

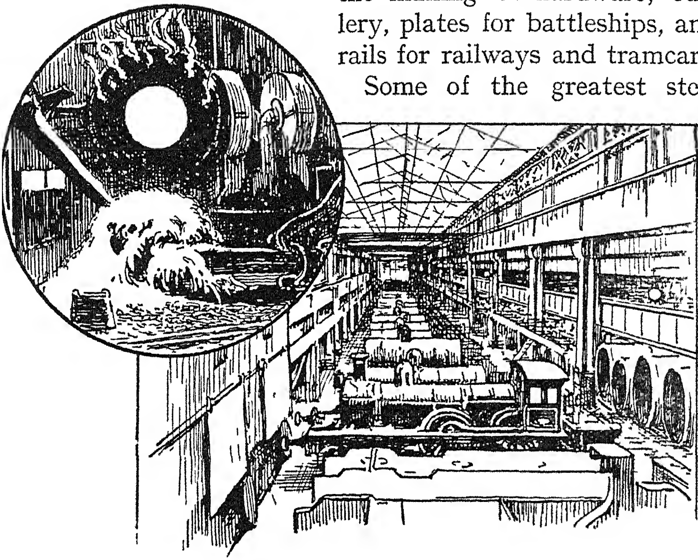
heat has been reached they are taken out to another set of rolls called the *mill rolls*. They are now rolled over and over, and bent upon themselves again and again until the separate lengths are welded into one bar, or plate.

As pure iron would be too soft for practical use, a very small proportion of carbon is left behind

In wrought-iron this usually amounts to one part in

every hundred, but cast-iron contains much more carbon, sometimes amounting to ten per cent.

By a special process of heating iron, or iron ore, steel can be produced, and as steel is harder and lighter than iron, and can be bent more easily, it is much used in the making of hardware, cutlery, plates for battleships, and rails for railways and tramcars. Some of the greatest steel works in the world are at Barrow-in-Furness, a town which rivals Middlesboro in its rapid growth. This town now has a population of about 70,000, but seventy years ago it was a tiny isolated Lancashire village, of which very few people outside Furness knew. The town has many natura advantages, and spacious dockyards have recently been built by Messrs Vickers,



IRON WORKS—(1) Steel-making
(2) A Locomotive Shed

where some of our largest battleships have been constructed. Mr Gladstone gave Barrow high praise in his speech on the occasion when the vast Devonshire Dock was opened: "With regard, gentlemen, to Barrow, I hardly know how to speak of the place in terms which would be adequate to the subject, and which at the same time would not appear to bear the character of exaggeration. But I must say that for combination of national advantages afloat and national advantages ashore, it probably would not be practicable to find a match for it in any part of the country."

In 1856 Sir Henry Bessemer adopted a method of removing carbon from pig-iron, and afterward adding the exact amount of carbon required. This process of manufacturing steel, known as the *Bessemer process*, was highly successful, and soon blast-furnaces were erected in Furness, which were able to produce a quarter of a million tons of pig-iron in a year. It is said that the Bessemer Steel Works at Barrow can manufacture over 4000 tons of steel in a week, and possibly the blades of your pocket-knives were originally made in these works, and afterwards fashioned by the Sheffield cutler. Workington, in Cumberland, specializes in steel rails.

The interior of a steel works presents one of the most picturesque views of industry it is possible to have. No display of fireworks is more brilliant than that given by the molten iron as it pours from the furnace into the converter, and as the carbon is blown out of the metal by the turning-on of the air-blast. It is stifling hot, and one cannot look with the naked eye on the huge reservoir containing the boiling, seething metal. All is bustle and activity; the grim-looking workmen, stripped to their waists, with the exception of a thin

cotton shirt, move about in their appointed places and perform their allotted tasks. Day after day they do the same kind of work, and the workmen in a large factory may be compared with the cogs of a mighty machine. Just as the smooth running of the machine depends entirely on the accuracy with which the cogs are adjusted, so a great manufacturing industry relies entirely on the adjustment of its human 'cogs.'

There is little of romance in the steel-worker's life, but perhaps, in times of meditation, the thought will come to him that he, with thousands of his fellow-craftsmen, is doing his share in sustaining the busy life of the world.

CHAPTER XXIV

A VISIT TO AN AERODROME

TO-DAY we will visit either Brooklands or Hendon, on the outskirts of London, where the two most important British aerodromes are situated. It does not much matter which we select, for similar scenes may be witnessed at both places.

Those of you who have not been to an aerodrome must imagine a very large open field, along the side of which are a number of little, low sheds, called *hangars*, where the air-machines are housed. Perhaps, too, there is a large stand for the accommodation of spectators, and dotted about the field are tall posts, known as *pylons*, which mark the turning-points to the aeronauts when engaged in their evolutions. The essential part of the aerodrome is the wide and fairly level space, with an entire absence of trees and hedges.

If we choose any Saturday in summer for our visit we shall probably see thousands of spectators crowding the various parts of the aerodrome set apart for them, and there are even more people standing on the heights outside. All manner of exhibition flights are arranged, and visitors, too, may enjoy a flight if they wish. Perhaps one of the most thrilling demonstrations is the 'altitude' test. The intrepid pilot comes from one of the hangars, in front of which his mechanics are engaged in looking to the nuts, bolts, screws, etc., on the

machine. After a thorough inspection of the aeroplane he jumps on to the little cane seat, placed, in this particular machine, just behind the engine and the propeller, and starts his engine, having first made certain that his mechanics have firm hold of the aeroplane. Perhaps he keeps the machine stationary for five or six minutes so that he may see if the engine is firing properly, and his experienced ear soon tells him if anything is wrong with its working. When he is satisfied that all is right he waves his left hand and shouts "Right!" At once the mechanics dart away; the machine runs rapidly forward for a short distance and then rises from the ground; and the airman, in large spiral curves, ascends into the air. We tremble to think what would be his fate if he fell from the dizzy height which he soon attains. After a time he begins his descent, but surely something has gone wrong! for the engine has stopped, and the propeller is only slowly revolving. We stand fascinated at the sight; the machine rocks in the air and suddenly takes a terrific dive. We quite expect to see the airman dashed to pieces before our eyes, but, on looking around, we notice that other spectators are calm and unconcerned, and our fears are dispelled. Just before reaching the ground, the airman tilts the machine slightly upward, restarts the engine, and drops to the ground as gently and gracefully as a lark alighting near her nest.

Extremely rapid progress has been made in airmanship during the last few years, and the aviation industry bids fair to be a highly important one in the near future. In 1906 all the world was talking of the successful flight of M. Santos-Dumont, the French aeronaut who, on Nov. 12th of that year, covered a distance of 230 yards

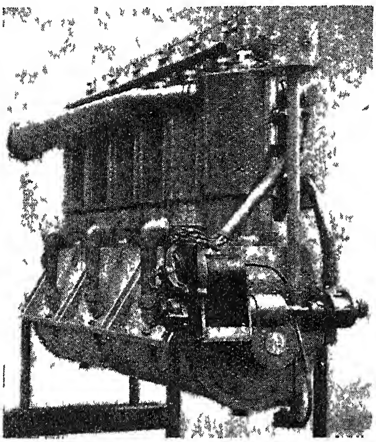
in a machine heavier than the air. The total length of his machine was 32 feet; its greatest width, 39 feet; its weight with one passenger 465 lbs.; its highest speed attained, 30 miles an hour. As a contrast to this it is interesting to note that the machine in which Mr Hawker made his flight for the £5000 prize offered by the *Daily Mail* in 1913—an account of which is given later—weighed, with airman and passenger, over a ton, and was capable of maintaining a speed of more than 60 miles an hour.

So rapid was the progress of airmanship that in 1910 a Frenchman succeeded in flying from London to Manchester, and the following year another French airman made a complete circuit of Great Britain. The first airman to cross the English Channel was M. Bleriot, who was also a Frenchman. Nowadays we think little of flights from England to the Continent, and those who live in the vicinity of the two great London aerodromes have grown so accustomed to the sight of air-machines that they scarcely trouble to look up as they pass.

One of the most famous British manufacturers of flying-machines is Mr T. Sopwith, in whose aviation works at Kingston-on-Thames, at the time of writing, one hundred and seventy men are employed. The Company can turn out one machine a fortnight, and it is anticipated that in the near future the works will be so extended that the output will be doubled.

Few inventors have had such a unique record in so short a time as Mr Sopwith. At the age of twenty-one he commenced a motor business, which promised to be a highly successful enterprise. But his attention soon became diverted to the new field opening so rapidly,

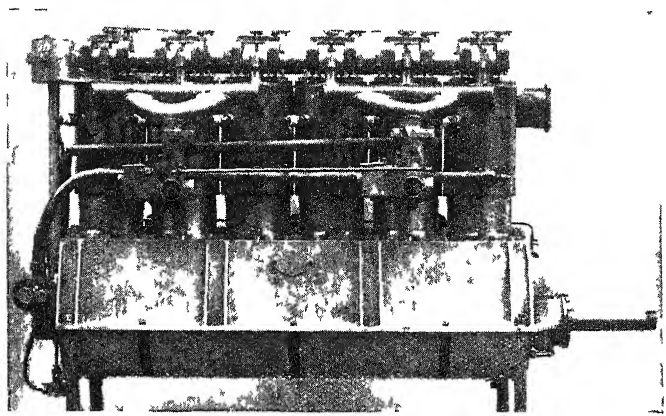
and in 1910 he learned to fly in a 'Howard Wright' biplane. Before the end of the year he had won the large prize of £4000, offered by Baron de Forest, for the longest flight made by an all-British machine from England to the Continent, by flying 177 miles from Eastchurch to the Belgian frontier in three hours and a half. The following year he went to America where he did some very fine flying. A notable achievement was to overtake the liner "Olympic" as she left New York Harbour, and to drop on board a parcel addressed to a passenger. In 1912 he won a gold cup and £250 in the first Aerial Derby around London. From that time Mr Sopwith has devoted his attention exclusively to the manufacture of aeroplanes and water-planes.



The Green Engine—End View

One of the most important features of the aeroplane is, of course, the engine, and the most significant result of Mr Hawker's famous attempt to win the *Daily Mail* £5000 prize in 1913 was the demonstration of the excellence of the 'Green' engine. This is manufactured by the Aster Engineering Company at Wembley, Middlesex, and its inventor is Mr George Green. Some of Mr Green's ideas were so novel and apparently impracticable that he had hard work in 1909 to convince engineering experts that it was worth while even to

experiment with them. One of his demands was that the cylinders of his engine should be made of cast steel, and it is said that to get the first six perfect cylinders made from steel cast in a British foundry, the Aster firm had to waste 250 castings, which were afterward sold as scrap iron. The cost of production for the first



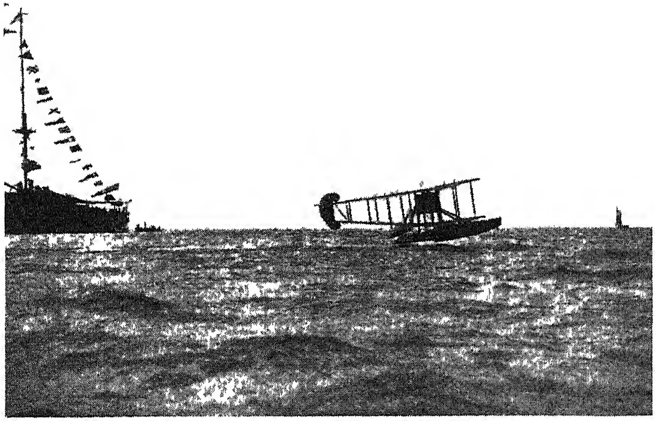
THE GREEN ENGINE—SIDE VIEW

engine was no less than £6000; now a 'Green' engine can be bought for £500.

Reference has already been made to the attempt of Mr Hawker to win the prize of £5000 offered by the proprietors of the *Daily Mail* for a waterplane flight round Great Britain.

Mr Hawker, with two other mechanics, came to England from Australia in search of employment in some aeroplane works, and was engaged by the Sopwith Aviation Company. He had made many daring flights before competing for the great prize, and had established

a record for the highest altitude attained by a monoplane. In describing this flight he said that the atmosphere was so cold at this great height—over 12,000 feet above sea-level—that he "felt like a block of ice," and he had the greatest difficulty in controlling the machine. At an earlier attempt, made in June 1913, he got up to 11,300 feet, when the carburettor froze.



A Sopwith Waterplane leaving the Water

About a fortnight later he rose 1000 feet higher, and in July he climbed to over 8500 feet with three passengers aboard his machine.

The main object of the *Daily Mail* in offering this particular prize was to test the capabilities of a British machine and a British engine. Previous prizes, each of £10,000, had been offered for flights to Manchester and a circuit of Britain respectively. Both prizes had been won by French airmen, using French engines and

the engine needed overhauling, and the airman was further delayed by having to descend at Montrose, where he stayed half an hour. Aberdeen was reached at 11 a.m., and an hour later the pilot was again on his way. From Cromarty, the next control, the route lay above the Caledonian Canal, and it was recognized that this would be by far the most difficult part of the flight, as

A SOPWITH WATERPLANE IN THE AIR

the Canal runs among lofty mountains, and the winds through the passes made aerial flight extremely difficult. Describing his experiences through the Caledonian Canal, Mr Hawker said: "At the entrance to the first of the narrow places we were bumped about so terribly that we could scarcely keep our seats. Some of the gusts took us square, rocked us sideways, and twisted us round, the wind smashing like a hurricane against the body and the rudder. On each side of us were

mountains two thousand feet high, and deep gullies between them out of which cross-winds came roaring. Besides that we had a wind of thirty miles an hour blowing dead in our teeth. It was impossible to control the machine. . . . Sometimes we were up 1500 feet; sometimes we sank to 400 feet. I could not control the height at all At times we went for four or five miles at no more than 400 feet up, trying to climb all the while, but unable to do so owing to the down-draught of the mountains. And all the time those merry bumps sideways! Some of the gullies I could see before we reached them; generally I could not, and the first I knew of them was the bumping. My plan had been to fly above the mountains, 4000 or 5000 feet up. That was impossible, for the tops of the peaks were in the clouds, and if I had gone up, I should have lost my course. We averaged only thirty miles an hour through the Canal, although my flying speed was sixty. The machine was very warm—in fact, too hot; hot water on each side of us, and a hot draught ahead."

Oban was not reached until six o'clock, where the pilot decided to spend the night, and take a much-needed rest to fortify him for increased exertions on the next day. At 5.40 a.m. on Wednesday he got ready to start for Dublin, but the machine would not rise properly, and it was discovered that one of the floats was full of water. This had to be baled out, at the expense of more precious time. Descents had also to be made at Kiells and Larne which involved further delays. At 11 o'clock another start was made, but when fifteen miles north of Dublin, the machine got out of control owing to the pilot's foot slipping from off the gear, and before Mr Hawker could recover, the waterplane was in the sea.

Fortunately the gallant young pilot was not injured, beyond a few bruises, but his passenger was not so fortunate; his arm was broken, and he was badly cut about the head. At the time of the catastrophe 1043 miles of the 1540-mile course had been completed, and this was the longest waterplane flight so far accomplished.

It was, indeed, a glorious failure, and Harry Hawker's name has taken its place on the long list of heroes who have done so much for the advancement of industry and science.

CHAPTER XXV

A TOUR ROUND A FAMOUS MOTOR WORKS

BY no means the least important of our great manufacturing industries is the Motor Industry, and a visit to the large Daimler Works at Coventry would be highly interesting.

For many years Coventry has been famous for the manufacture of clocks and watches, silks and ribbons, various kinds of machinery, bicycles, and, recently, of automobiles. There are several other important motor works in this Warwickshire town besides those owned by the Daimler Company, and when we learn that the Daimler Works alone cover thirteen acres of ground, and employ 5000 people, we have some idea of the importance of Coventry as a manufacturing and industrial centre.

Perhaps no industry has made more remarkable progress. In the early years of Queen Victoria's reign the stage-coach, which up to that time had been the principal means of travelling in this country, was superseded by the railway train. Later on the bicycle—the first of the modern horseless vehicles—appeared, and after many improvements had been made in the various forms of 'cycle,' the internal combustion gas-engine was developed by British and foreign engineers. This was followed by the benzine motor-engine, or, as it is generally called, the petrol engine. At first the benzine

Chassis-erecting Department of the Daimler Works

motor was fitted to the form of bicycle then in use, and this crude motor bicycle might have been seen running on the roads in the early part of 1895. As, however, it was so extremely cumbersome and difficult to steer, it was decided to apply the engine to the tricycle, and, in time, a four-wheeled motor vehicle was evolved. This was known as a quadricycle, and it was really the basis on which the modern motor-car has been designed.

In these early days of the motor industry considerable opposition was met with from the authorities. Various Locomotion Acts were passed which forbade the use of motor vehicles on British highways. Later on, when motor traction was legalized, speed was strictly limited, and you may have seen a picture of a man of the period walking a short distance in front of a traction engine carrying a red flag. You can judge from this the speed at which mechanically-driven vehicles travelled. The public, too, were greatly prejudiced against the new method of travelling. Mothers said that their children would be maimed or killed, and that it would be unsafe to walk along the road; country farmers complained of the dust which the cars made, and, indeed, nearly, everyone, except the manufacturers and the fortunate possessors of motor-cars, showed ill-will toward the new industry.

In 1895 a tour of the country in a Daimler-engined car was undertaken by two gentlemen, and this tour greatly influenced public opinion, and impressed people with the stupidity of the law with regard to locomotion. Various exhibitions were held at which our British manufacturers displayed their newest inventions in motor-engines and cars. In May 1896, a very important exhibition in London at the Imperial Institute

was opened by the Prince of Wales. As a result, a Bill to amend the existing road Locomotion Acts was passed by Parliament and the motor-car became legalized on British highways.

Following promptly upon this the makers of motor-cars organized a run from London to Brighton. A writer, in describing this, says:

"The famous 'Emancipation Run' from London to Brighton, which took place on November 14th, 1896, will always be remembered in the annals of British motorism. This event marked the starting-point from which the industry in this country was set free in pursuit of the Continental branches with their five years' good start. What a revelation of the past fifteen years' progress is provided by the record of this first run! Some forty cars of all makes and types were gathered together at the starting-point; after innumerable adventures and hair-breadth escapes, thirteen vehicles reached Brighton."

It would, indeed, be hard to realize how the busy life of the world could be carried on without the use of the motor. In every street we may see horseless vehicles, and they are being turned out in hundreds every week. The Daimler firm alone delivers each week, on the average, nearly a hundred cars. Of the manifold uses of the motor, the following extract will be interesting:

"The world-wide importance of the automobile at the present day cannot be over-estimated. Into every quarter of the globe the self-propelled vehicle has won its way, carrying civilization and progress into distant lands where railways are yet unknown. Great as was the part which the iron road played in the spread of

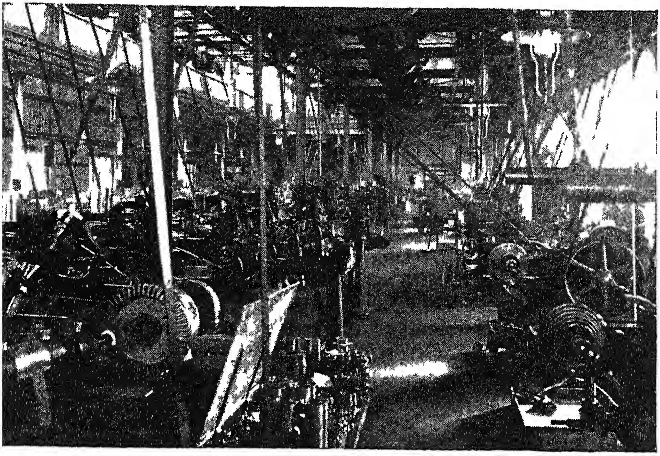
civilization during the nineteenth century, no one can doubt that the automobile is destined to play a part of still greater benefit to mankind during the present century.

"The automobile is essentially a free-moving agent, unfettered by the limitations of an iron track. Its progress carries it into all regions, opening up new countries, and carrying the supplies and implements for the conquest of the unknown.

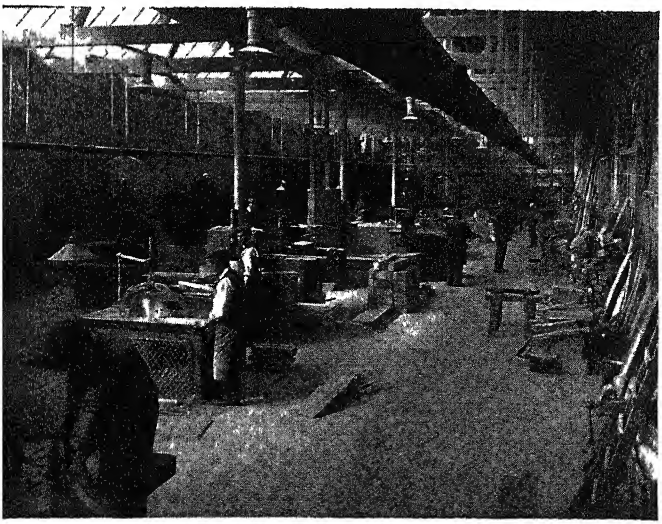
"The hidden secrets of the Dark Continent are being revealed to the intrepid explorers who even now are steering their automobile from the Cape to Cairo; China and the Far East have long since been traversed by the motor-car's rubbered wheels. The arid sandy wastes of mid-Australia, the grave of so many daring explorers, are safely crossed by the modern prospector in his car, while the dash for the South Pole is rendered easier of accomplishment by the motor-propelled sledge.

"In the second stage, that of the development of the new country, the automobile is invaluable to the farmer. The agricultural motor tractor lays vast tracts of country under cultivation; the same machine reaps and binds the ripened crops, and then carries to the distant market the fruits of the season's toil, afterward returning with provisions and further supplies for the cultivation of new tracts. Thus the story of progress in every land: in Canada and South America strikingly so at the present time."

It is estimated that of commercial vehicles alone, such as motor omnibuses, lorries, vans, and so on, there are considerably over a quarter of a million on the road. In rural districts the horse is also being supplanted by the motor.



DAIMLER GEAR-CUTTING SHOP



DAIMLER SAWMILLS

The Daimler Company claim for their works the honour of being the largest motor factory in Europe, and certainly our chief impression will be one of bewilderment as we walk round the thirteen acres of shops, where many different trades are carried on. The works can be divided into five chief departments comprising (i) Foundry; (ii) Machine and Fitting Shops; (iii) Erecting and Fitting Shops; (iv) Coach Building Shops; (v) Testing and Delivering Department.

Quite one of the most important branches of motor construction is that which is carried on in the large and well-lighted drawing office. Here the first practical work is done toward producing a car; the draughtsmen produce intricate plans from the ideas and rough designs of the Company's engineers, and these plans are accurately drawn to scale so that the workmen can make practical use of them. It is interesting to learn that the metric system is employed for practically all measurements.

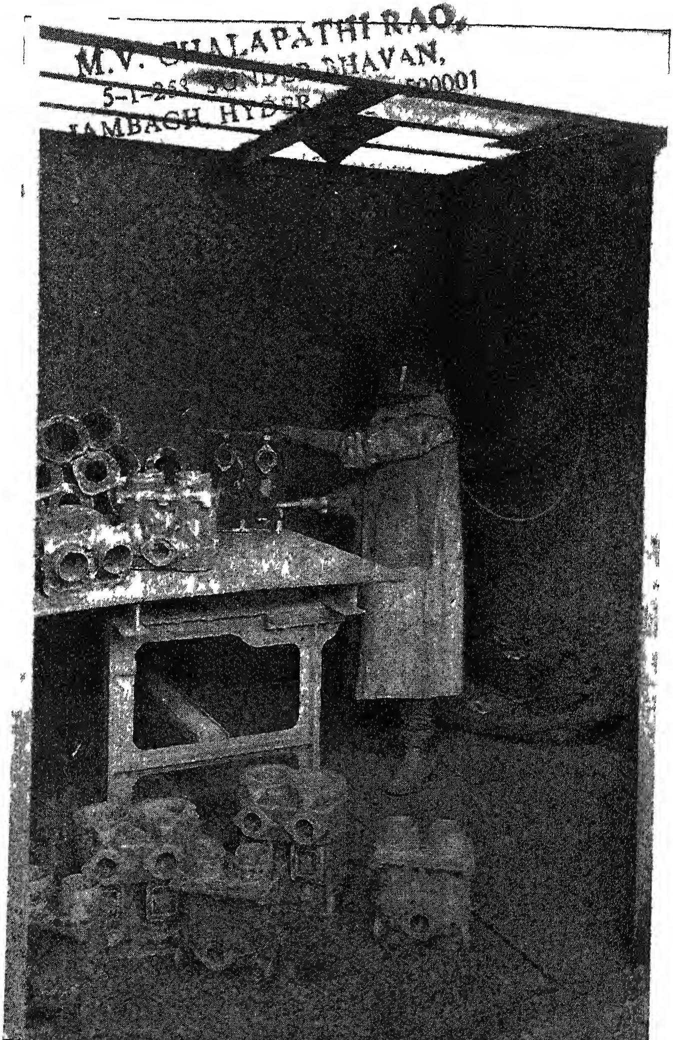
In close touch with the drawing office is the works department. Here estimates are obtained of the cost of all materials required in every branch of the work. The laboratory near by is used to test the chemical and physical properties of every part of the car.

The machine and fitting shops are concerned mainly with the production of the various parts of machinery in use in a motor-car, such as engines, gear-cases, brakes, and so on. These parts are 'assembled' in the erecting and fitting shops. Here skilled fitters put together the component parts, and the work is arranged in such a way that each gang of men is always employed in fitting the same parts; thus each man becomes a specialist in his own work.

The curious illustration given on the next page, which somewhat suggests a diver standing before a table, shows us a man cleaning castings and hardened parts that have been through the fire by a process known as the 'sand blast.' Why it is thus called is not quite certain, for fine chilled iron shot is actually used. The curious helmet is to protect the lungs and face of the workman, and fresh air is pumped into it through the pipe at the top. The larger pipe seen in the man's hand carries the blast.

The visitor to the Daimler Works notes the healthy, well-lighted, and well-ventilated character of the shops. We usually think of a smithy as a smoky, dirty and unhealthy place, but in the smiths' shop at the Daimler Works dirt and smoke are almost entirely absent. Each forge is fitted with a large hood to collect the smoke and fumes, which are drawn upward by a large exhaust fan to be ejected through a chimney in the roof.

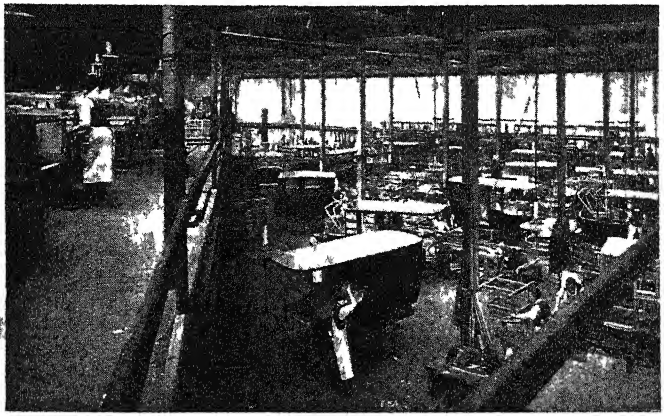
It was usually the purchaser's practice to order the body of his car from a firm of coach-builders, and the engine from a motor company. But nowadays the leading firms turn out complete cars, and quite one of the most important departments in the Daimler Works is the body shop. This consists of a ground floor for building the main part of the body of the carriage, and a gallery where smaller details are dealt with. The wood, which has been 'seasoned,' perhaps for years, in the timber yard, has first been cut roughly to shape in an adjoining saw-mill. Sections of the coach-building department are concerned with painting, upholstery, and plating. We are told that coach-painting is quite an elaborate art, and that there are no less than sixteen distinct coats on the lighter coloured cars and more



Sand Blasting at the Daimler Works

on the darker ones. Great care is taken to keep the paint shop as free from dust as possible.

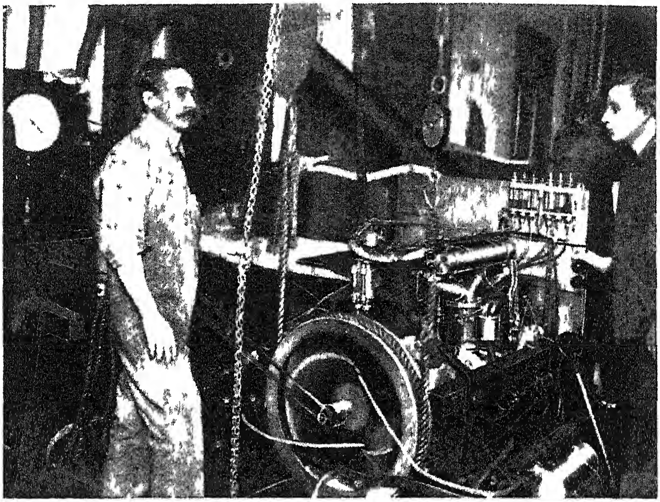
The chassis, after being stripped of the fittings which have to be plated, is painted in one room, and the body of the coach in an adjoining shop. The final coats of varnish are put on in a dust-proof room, and then the body is ready for the upholsterers.



THE DAIMLER BODY SHOP

After one has seen the number of tests and inspections to which the engine and machinery have been submitted, one wonders however those mysterious breakdowns occur on the road. After each machining process each part passes through the inspection department, and in the test shop the engine, as received from the engine-building shop, is mounted on a stand and run under its own power, but without load, for eighteen hours. After the necessary adjustments have been

made, the engine is run against a brake for two hours at full power, and then it is taken to pieces and thoroughly examined. If satisfactory, a still further test is made,



Engine-testing in the Daimler Works

and the engine is finally ready for the erecting shop. As soon as this department has turned out the chassis, the engine is submitted to searching road tests, and when the beautifully-varnished and richly-upholstered body has been fitted, the superintendent again inspects and tests it before it is delivered to the purchaser.